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AN EXPERIMENTAL STUDY OF THINKING

BY
EDNA HEIDBREDER, M.A.

Submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in the Faculty of Philosophy,
Columbia University

REPRINTED FROM
ARCHIVES OF PSYCHOLOGY
R. S. WOODWORTH, EDITOR
No. 73

NEW YORK
OCT. 1924

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ACKNOWLEDGMENTS

The writer takes this opportunity to express her high appreciation of the assistance she has received in making this study. She is especially indebted to Professor R. S. Woodworth for suggestions concerning the experimental procedure and the treatment of results, and for a careful reading of the manuscript. She is also indebted to Professors H. L. Hollingworth and A. T. Poffenberger for helpful conferences. In a special sense, she is under obligations to a number of her fellow students, and wishes at this time to express her thanks to Misses Helen Burkhart, Constance Dowd, Dorothy Goldsmith, Kate Hevner, and Elizabeth Hurlock, and Messrs. Mortimer Adler, Wm. Brown, Sidney Newhall, Wm. Clark Trow, and James Weinland, who acted as subjects; and to Misses Leatha Jones, Kate Lewis, Lulu Stevens, and Mrs. E. H. Tyndale, who helped to determine the objective validity of the results by making detailed examinations of parts of the record.

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An Experimental Study of Thinking

CHAPTER I

The Problem and the Method

The general plan of this study was to place intelligent human beings in situations which forced them to think and to get as faithful a record as possible of their activities. Its purpose was to obtain actual specimens of human thinking and to submit them to inspection and analysis.

This program makes two very obvious demands; first, that the subjects be made to think; and second, that their thinking be made observable. Since the experimental procedure was determined largely by these demands, their implications ought to be considered at once.

The Meaning of the Term Thinking

In the first place, it is necessary to state explicitly how the term "thinking" is used in this experiment. Naturally, since this is the very activity to be investigated, any definition given at this time is provisional. But after all, the term "thinking," as it is generally used, refers not so much to processes as to results; or rather, when certain results are produced under certain conditions, it is assumed that thinking has taken place. It is possible, therefore, to identify a process as thinking without knowing what the process itself is like; and in this study it is assumed that thinking has occurred when an organism has produced a response having the following characteristics.

1. The response must be "adequate." If thinking is successful,[1] it will result in a satisfactory adjustment to the

[1] Of course, not all thinking is successful, but the criterion of adequacy of response is based on cases in which thought reaches what may be called its natural termination. It is as characteristic of thinking that a solution shall be found, as it is of learning that something shall be learned, or of memory that something shall be remembered, or of reflex action that the stimulus shall elicit the appropriate response. All these processes are subject to inadequacy and failure, but the criteria of the activities in question are based on occasions when the mechanism works effectively. Adequacy of response is particularly useful as a criterion of thinking, in distinguishing it from reverie.

conditions which stimulated the process. That is, it will dispose of the situation to be met by removing it as a stimulus to thought. It may still act as a stimulus to the response which thinking has provided, but thought will no longer be required to produce it.

2. The response must be "novel." Though the materials of which it is made will, of course, be supplied by the organism's existing equipment, it must be new as a response to the stimulus in question. It must be a reaction which the organism has not been prepared to make to that particular stimulus, either by its original nature or by its past experience.

3. The response must be "invented." The subject must not be told the correct reaction and then left to acquire it by learning it. The response must be the organism's own discovery, not a copy of something somehow "given" in the situation.

4. The response must be the result of activities which are "implicit"[2] as opposed to "overtly motor." The activities which occur in the course of thinking are events within the thinking organism itself. An adjustment which may be explained as the outcome of overt motor activity alone, is usually not considered thinking. Though a cat in a puzzle box may produce a response which is "adequate," "novel," and "invented," its activity is hardly to be regarded as thought; and the reason is that the production of the response which constitutes the solution can be accounted for entirely in terms of overt motor reactions.

Thinking, then, as the term is used in this study, denotes any activity which, by some means other than overt motor reaction, produces responses which are adequate, novel, and invented. By adopting this definition, the experiment can draw up definite specifications for its subject matter and still leave the nature of the process open to question.

The General Nature of the Experiment

As a second point, it is the business of the experiment to make the processes involved in thinking observable. In order

[2] "Implicit" is used in Watson's sense as the opposite of "overt."

to do so, it was considered advisable to adopt three rules: first, to reduce the activity to very simple terms; second, to get objective indications of the course it was taking; and third, to exhibit it while it was actually in progress, not after it had taken place. That is, it was assumed that thinking is difficult to observe principally for three reasons: because it is so complex that it is hard to follow; because it is "private" or "implicit" and does not permit collaboration on the part of several observers; and because it is "transitive" rather than "substantive" and presents all the difficulties which those states offer to observation.

As a means of arousing thought in conditions which would make it observable, the following experiment was devised.

Essentially, it consisted in placing the subject in an artificial world to which he was required to adjust himself satisfactorily. Because of its artificiality, it made his existing responses inapplicable and left him unprepared for the conditions in which he found himself. But in spite of this fact, he was confronted with situation after situation to each of which he was expected to respond in some way. Furthermore, there was a definite implication that he was eventually to respond correctly, according to the arbitrary but consistent standards of this world; and though he had no way of knowing what to do, he was left almost entirely to his own devices in discovering the correct response. Besides, the materials with which he was required to work could not be managed by overt manipulation alone. On the whole, the world was constructed so that the "adequate" response must be "novel," "invented," and "implicit."

It was also constructed so as to fulfil the three conditions favorable to observation. Simplicity, the first condition, was secured in two ways. In the first place, the world was deliberately made simple by constructing it of a few simple elements and by making all the situations which the subject encountered, combinations of two, or at most, three of those elements. In the second place, the artificiality of the conditions forced the subject back to the primitive level of one who meets a problem in utter ignorance; the activities involved were not overlaid with a mass of knowledge which obscured the activities themselves. The second condition favorable to observation, that of securing an objective record, was fulfilled

by regularly requiring motor performances dependent on the "implicit" activities. And in order to fulfil the third condition and expose the process while it was actually going on, overt reactions were required throughout the entire course of the problem, not only after it had been solved.

The bearing of these matters will doubtless become clearer when the procedure is explained in detail.

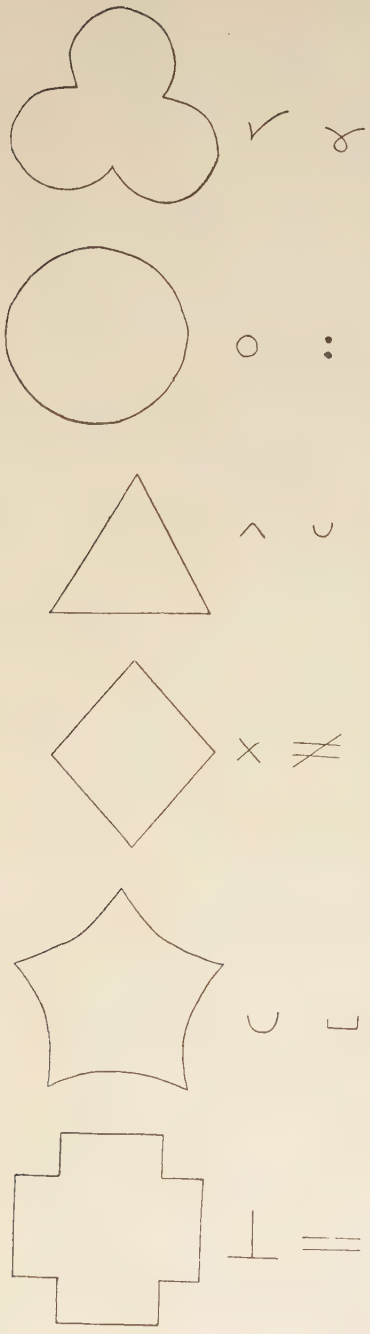
The Experimental Procedure in Detail

I. *Introduction*

The first part of the procedure was primarily an introductory measure. It consisted principally in familiarizing the subject with the elementary situations of the new world and giving him a definite response to each. Naturally, the subject himself was not informed of this fact but was started upon his task with the minimum of instructions.

First he was shown a card like that in the illustration and was given the following information. "I am going to show you a number of cards like this one. Each one will have one large figure and two small ones. The same figures will not be used on all the cards, but on each one there will be a large figure to take the place of the square and two small ones to take the places of the semicolon and division sign. You are to place one of the small figures inside the large one and when you have finished, I'll tell you whether you are right or wrong. Are you ready to begin?" If the subject asked questions which showed that he did not understand the instructions as given, the necessary explanations were made; but if his questions were requests for additional information, he was told, "There aren't any further instructions." Most subjects simply restated the instructions in substance and asked to be assured that they were right. In no case did the experiment proceed until the subject was satisfied that he understood what was required of him.

Cards like those in the next illustration were then pre-



sented, one at a time, in the order shown. The experimenter had arbitrarily decided which of the two small figures was the "right" mark for each large one. The time that elapsed between the presentation of the card and the reaction of the subject was taken by means of a stop watch which registered to tenths of a second. As soon as he had marked a card, the subject was asked, "Will you please tell me everything that went on in your mind from the time you saw the card to the time you marked it?" The verbatim report and the reaction time were recorded immediately by the experimenter and numbered to correspond to their position in the series of overt reactions which the subject was making. After the report was recorded, the subject was asked, "Is there anything else?" This question was asked as a matter of routine and in the form given in order to encourage completeness of report without suggesting its content. When a subject had marked a card and reported on his reaction, the card was taken by the experimenter and placed face down on the table or on the card last used. In this way, the cards were kept in the order in which they had been marked. Just before the next card was presented, the subject was told regarding his last per-

formance, "That was right" or "That was wrong."[3] This statement served two purposes. Its principal function was obviously to inform the subject whether he was right or wrong; but incidentally it served as a ready signal for the presentation of the next card.

After the series of six had been presented and reacted to in this way, the subject was shown a card like the first one of the series with the two small figures omitted. This card was presented without instructions. If the subject asked "What am I supposed to do?" or anything of like nature, he was told, "There are no further instructions." All the subjects but one marked the card in some way and after the reports and reaction times had been taken, were told whether their performances were right or wrong. In case they were wrong, they were shown the corresponding card of the original series and told whether that one was correctly or incorrectly marked. One subject did not make any overt response to the card and at the end of two minutes the watch was stopped and his report taken as usual. He was then told that he was expected to mark every card in some way, even if he did not know exactly how it should be done. When the next card was presented, this subject reacted as the others did and the series was continued in the regular way. This procedure was kept up in the case of all the subjects until each one had learned the correct response for each situation—i.e., until he had gone through the whole series twice in succession without making a mistake.

This part of the procedure served three purposes.

1. It provided the subject with a number of elementary responses on which to base his thinking. The experiment deprived him of his existing modes of reaction, and if he were not supplied with something to take their place, he might respond to the total situation by doing nothing at all.

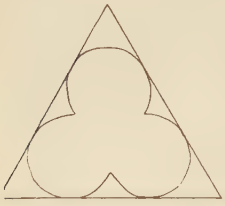
2. It gave the subject a necessary mental set. The experiment required him to make some overt reaction to every situation he met and this often implied responding when there was no particular reason for doing one thing rather than another. This general habit was established during this part of the procedure.

[3] The "right" marks were ⌣, o, ∧, ×, ∪, and =. The subject understood that "right" and "wrong" always referred to his overt performance, never to anything he said in his report.

3. It familiarized the subject with the general procedure before the experiment proper began. By the time he met his first problem, he was used to being timed with a stop watch, had formed the habit of giving a report, and had learned how "rights" and "wrongs" were used in this connection.

II. *The Experiment Proper*

The experiment proper began when the subject was presented with a situation like that given in the accompanying illustration. The experimenter had decided that the correct response to a situation of this sort was to mark the inner figure with its own symbol. The situation was presented with no instructions and with no indication that the experiment was really beginning at this point. The reaction time was taken, the report called for and recorded, and the subject told whether he was right or wrong in the regular way. A second situation was then presented, like the first in arrangement, but composed of different figures. A series of cards had been prepared in which this arrangement was carried out with all the possible combinations of the six figures given in the original series. The cards were presented successively and in random order, according to the procedure described above, until the subject had discovered the correct response. A problem was considered solved when the subject marked a card correctly, stated a rule which would give successes consistently, and followed his successful reaction with four correct performances.

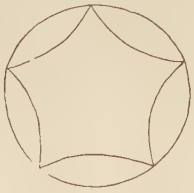


The rest of the experiment consisted in solving the remaining problems according to the same procedure. The problems were of the following sorts.

Class A

The problems of this class were similar to the one just described in that they were presented without clues or aids of any kind. They were:

A I *Situation:* Two figures, one inside the other.

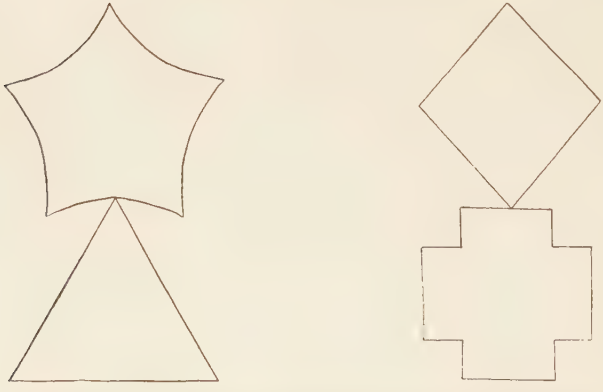


Solution: Mark the inner figure with its own sign.

A II *Situation:* Two figures, side by side, one curved and one rectilinear. The surved figure may be either to the right or left of the other.

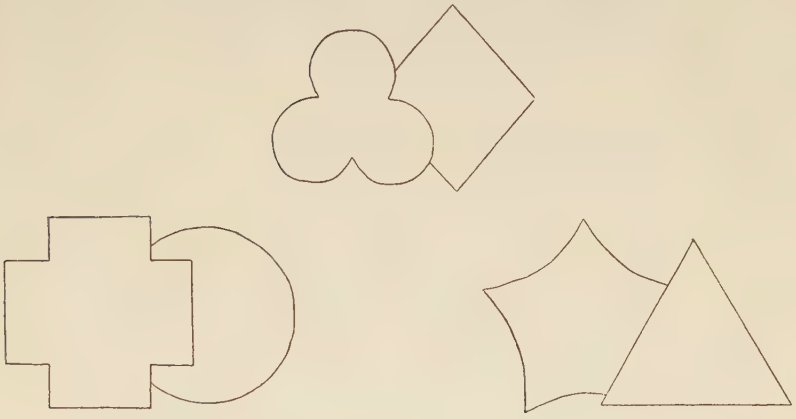
Solution: Mark the curved figure with its own sign.

A III *Situation:* Two figures, one above the other, one having a larger number of sides than the other. The figure with the larger number of sides may be curvilinear or rectilinear, and above or below the other.



Solution: Mark the figure with the greater number of sides with its own sign.

A IV *Situation:* Two figures side by side, one curved and one rectilinear, one complete and one incomplete. The incomplete figure may be to the right or left, composed of curved or straight lines, and have a larger or smaller number of sides than the other.

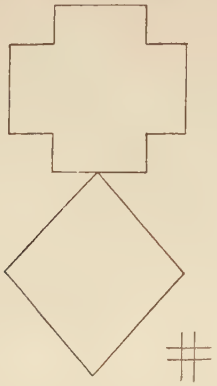


Solution: Place the sign of the incomplete figure inside the curved figure. In some situations this means marking the incomplete figure with its own sign, in others marking the curved figure with the sign of the incomplete.

A V *Situation:* Situation A II with the addition of an asterisk in red ink.

Solution: Mark the rectilinear figure with its own sign. (The opposite of the solution of A II.)

A VI *Situation:* Situation A III with the addition of a sharp in red ink.



Solution: Mark both figures, each with its own sign. (Not the opposite of the solution to A III.)

It is hardly necessary to add that, in presenting these cards, the experimenter did not mention straight and curved lines, large or small number of sides, or the presence of figures like the asterisk. The subject was simply confronted with the situation and left to discover its characteristics for himself.

In the remaining problems, the subjects were given aids of various sorts, but in no case did the aid give the solution outright.

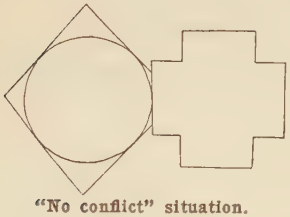
Class B

In this class, each problem was a combination of two problems formerly used. For example, B I was a combination of A I and A II in two possible forms. In the first form, the situation was so arranged that the inner figure of A I was the curved figure of A II, and would therefore be marked according to the subject's past experience with both component situations. In the second form, the inner figure of A I was the rectilinear figure of A II and, since the two previously used rules were in conflict, it became necessary for the subject to discover which took precedence over the other.

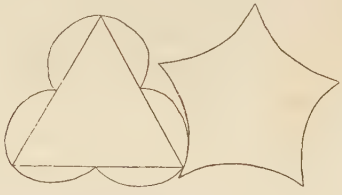
This situation, again, was not explained to the subject; he was not even told that the new situation was a combination

of two old ones. He was first given a situation of A I, then of A II, and required to mark them. If he had forgotten the correct marking in any case, it was demonstrated to him by the experimenter and the rule was stated. Just before the first situation of B I was presented, he was told, "You will be able to use both those rules in this problem." The first situations presented were of the "no-conflict" type and were continued until the subject had made five correct reactions in succession. Then the "conflict" type was introduced and from that point on, both forms were used.

B I Situation: Combinations of A I and A II, representing both "conflict" and "no-conflict" situations.



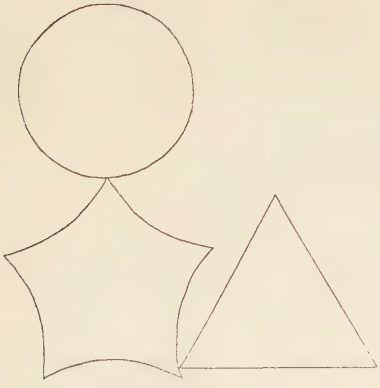
"No conflict" situation.



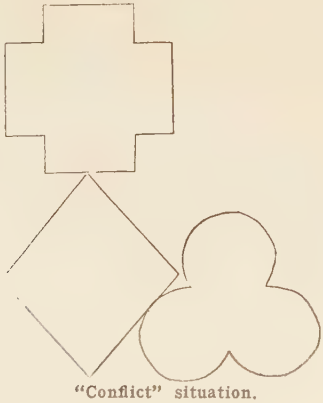
"Conflict" situation.

Solution: Mark the correct figure according to A II.

B II Situation: Combinations of A II and A III, representing both "conflict" and "no-conflict" situations.



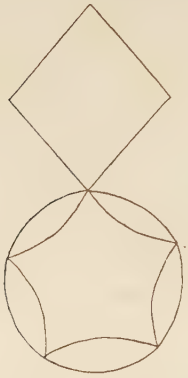
"No conflict" situation.



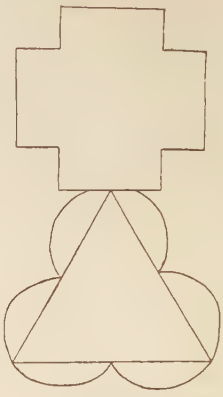
"Conflict" situation.

Solution: Mark the correct figure according to A III.

B III Situation: Combinations of A I and A III, representing both "conflict" and "no-conflict" situations.



"No conflict" situation.



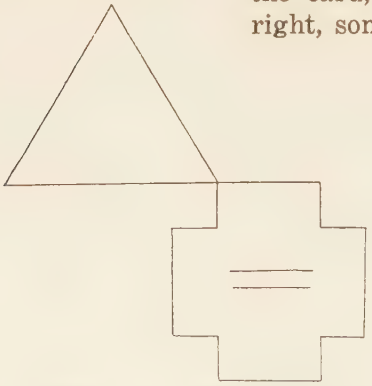
"Conflict" situation.

Solution: Mark the correct figure according to A III.

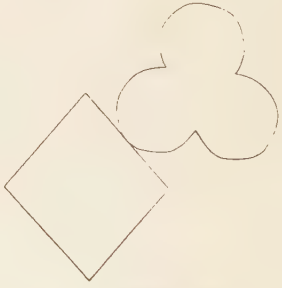
Class C

In Class C, the aids consisted of sample cards, displayed immediately before the first situation of the new problem was presented. The sample cards indicated correct, and, in some cases, incorrect ways of marking the situations. The subjects were told which samples were correctly marked and which incorrectly marked, and were permitted to keep them exposed throughout the problem.

C I Situation: Two figures arranged along a diagonal of the card, the lower figure sometimes to right, sometimes to the left of the upper.



Sample card, correctly marked.



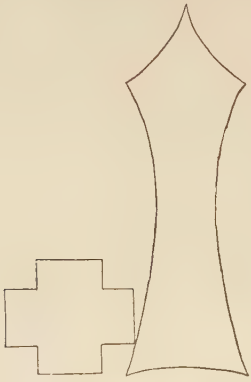
Problem card.

Problem cards include arrangements similar to that shown in the sample and also to that in the illustration marked "problem card," where the right hand figure is higher than the other figure.

Solution: Mark the figure on the right hand side with its own symbol.

C II Situation: Two figures, side by side, one elongated. The elongated figure may be to the right or left of the other, either curvilinear or rectilinear, and composed of a smaller or larger number of lines than the other.

Sample card, correctly marked.

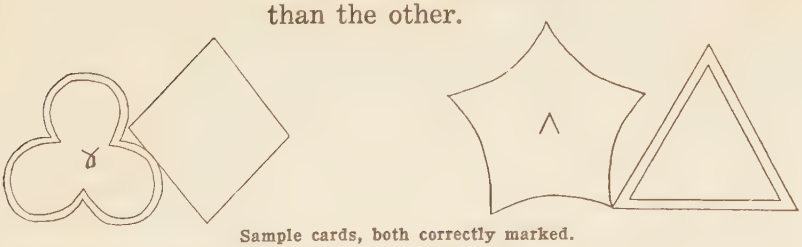


Problem card.

Problem cards include arrangements similar to that shown in the sample card, and also to that shown in the illustration marked "problem card," where the elongated figure is on the right.

Solution: Place the sign of the elongated figure inside the other figure.

C III Situation: Two figures, side by side, one with double lines. The figure with double lines may be to the right or left of the other figure, curvilinear or rectilinear, and composed of greater or smaller number of sides than the other.

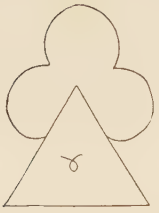


Sample cards, both correctly marked.

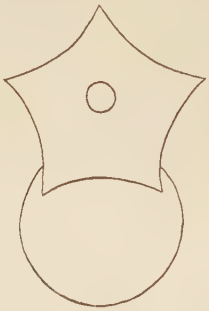
Problem cards include situations similar to those shown in the samples, and also arrangements in which the left figure is rectilinear.

Solution: Place the sign of the figure with double lines inside the figure on the left.

C IV Situation: Two figures, one above the other, one complete and one incomplete. The incomplete figure may be above or below the other, rectilinear or curvilinear, composed of a greater or smaller number of sides than the other.



Sample card, correctly marked.

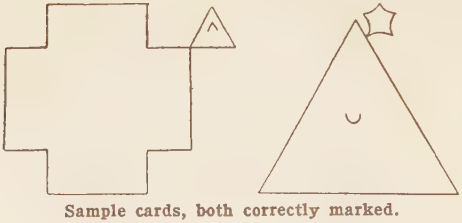


Sample card, incorrectly marked.

Problem cards include arrangements similar to those shown in the samples.

Solution: Place the sign of the incomplete figure inside the lower figure.

C V Situation: Two figures, one very small. The small figure may have a larger or smaller number of sides than the large figure and be either curvilinear or rectilinear.



Sample cards, both correctly marked.

Sample cards, both incorrectly marked.

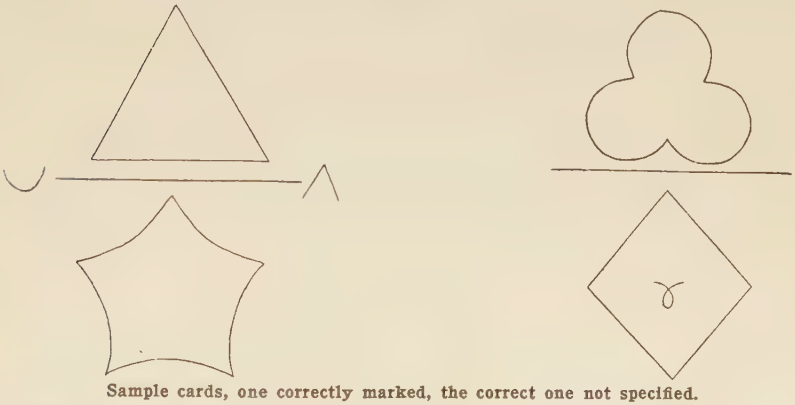
Problem cards include arrangements similar to those shown in the sample cards.

Solution: Place the sign of the small figure inside the figure with the smaller number of sides.

Class D

In Class D, sample cards were used, but with less definite clues than those used in Class C. The subjects were given two or four samples and told, "One of these is right. The others are wrong," but were not told which one was right.

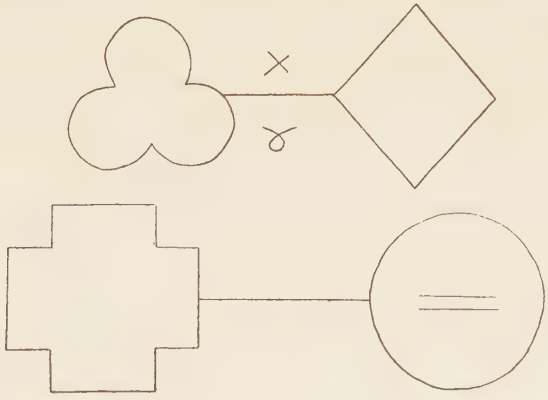
D I Situation: Two figures, one above and one below a horizontal line, one curved and one rectilinear. The curved figure may be above or below the line.

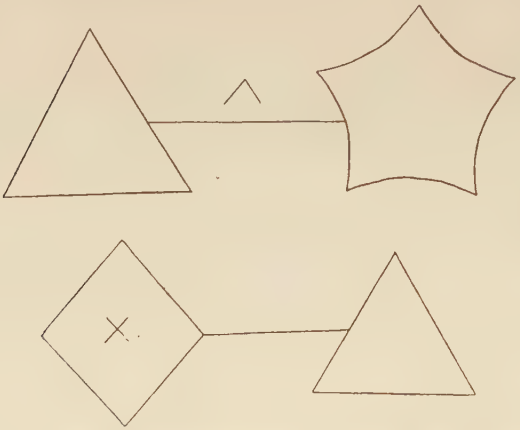


Sample cards, one correctly marked, the correct one not specified.
Problem cards include arrangements similar to those shown in the sample cards.

Solution: Place the sign of the curved figure inside the figure with straight lines.

D II Situation: Two figures connected by a horizontal line.





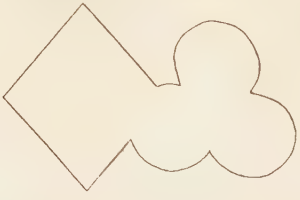
Sample cards, one correctly marked, the correct one not specified.
Problem cards include arrangements similar to those shown in the sample cards.

Solution: Place the sign of the left figure above the line connecting the two figures.

Class E

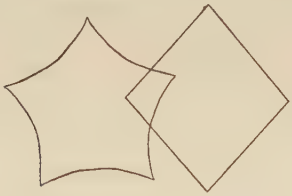
In Class E, the aids consisted in confirming true hypotheses in one problem and in eliminating false ones in the other. For example, the subject was told, after marking a card, "That was wrong but you are right about thinking that the number of sides has something to do with it," or in the other problem, "That was wrong. It has nothing to do with position to the right or left."

E I Situation: Two incomplete, joined figures. True hypotheses confirmed.



Solution: Place the sign of the figure with the smaller number of sides in the figure on the left.

E II *Situation:* Two interlacing figures, one with curved, one with straight lines. False hypotheses eliminated.



Solution: Place the sign of the curved figure inside the figure with the larger number of sides.

These problems were not all solved at one sitting, but were distributed over four days. On each experimental day, the subject gave approximately two hours to the task, solving as many problems as he could in that time. Two or three days elapsed between each experimental day and the next, so that for a given subject the experiment covered nearly two weeks. At the beginning of each sitting, the subject was required to react to each of the original elementary situations and also to the problems he had previously solved. If he reacted incorrectly, he was reminded of the correct response before the new problems were presented. This was done as a means of restoring the subjects's knowledge to the condition in which he had left it at the end of the preceding sitting.

III. *Order in Which Problems Were Presented*

The problems were not presented to the subject in the order in which they have been described, but were arranged in a sequence determined by the following considerations.

1. It was necessary that each problem contain one element of novelty. The novel element might be a feature not previously reacted to, such as the number of sides in a figure, or a new relation of features previously used, such as that involved in placing the sign of the curved figure inside the figure with the smaller number of sides. Since cases of the latter sort presupposed familiarity with the terms involved in the relation, it was necessary that they be preceded in the series by problems involving those terms.

2. It was desirable that no one concept enter successively into the solution of a series of problems. For example, it would detract from the novelty of the situation if several problems involving a distinction between rectilinear and curvilinear figures immediately succeeded each other.

3. An attempt was made to keep the effects of practice from being concentrated on problems of any one kind. Problems with clues, for example, were scattered throughout the series, and problems involving the use of similar clues or the same amount of aid were separated from each other. Because of the two considerations previously mentioned, no arrangement could be made which absolutely equalized the effects of practice, but it was possible to arrange the series so that different kinds of problems shared its influence to approximately the same degree.

On the basis of these considerations, the following sequence was arranged:

1 — A I	7 — B III	13 — D I
2 — C I	8 — A IV	14 — B II
3 — D II	9 — E I	15 — C IV
4 — A II	10 — C III	16 — E II
5 — B I	11 — A V	17 — C II
6 — A III	12 — C V	18 — A VI

This arrangement takes the first two considerations into account satisfactorily and in a measure takes care of the third.

As regards practice, there is reason to believe that it was not a very important factor in this experiment. It will be remembered that, in the preliminary exercise, the subjects became habituated to the general conditions before the experiment proper began. But what is more to the point, the results do not present the appearance of having been influenced by practice. If the number of trials required for the solution of a problem can be regarded as a measure of the subject's facility in dealing with it, the following evidence may have some bearing on the question. In the table below, the problems are arranged in the order in which they were presented, and the average number of trials required for the solution of each is indicated. In the first column of averages, all the problems of the experiment are represented in order;

in the other columns, the problems of each class are treated in similar fashion.

Sequence	Problem	Average Number of Trials: All Problems	Class A	Class B	Class C	Class D	Class E
1	A I	9.8	9.8				
2	C I	13.1			13.1		
3	D II	3.1				3.1	
4	A II	16.5	16.5				
5	B I	7.0		7.0			
6	A III	26.9	26.9				
7	B III	9.5		9.5			
8	A IV	29.3	29.3				
9	E I	8.4					8.4
10	C III	2.9			2.9		
11	A V	5.3					
12	C V	3.1			3.1		
13	D I	6.9				6.9	
14	B II	25.7		25.7			
15	C IV	9.3			9.3		
16	E II	8.1					8.1
17	C II	9.9			9.9		
18	A VI	16.1	16.1				

That is to say, the problems when placed in temporal order do not give a practice curve, when considered either as a single sequence or as separate classes.

IV. *Miscellaneous Details of the Procedure*

This account gives the broad outlines of the experiment, but there are several points which ought to be brought out more specifically.

1. The materials required a certain amount of preparation. The "cards" referred to were slips cut from sheets of paper on which the various arrangements of figures had been mimeographed. They were arranged in series before the experiment began so that they could be presented without delays or breaks in the procedure. In each problem, the series was arranged so that no two successive situations were exactly alike and, so far as possible, so that the same elementary figure appeared on no two successive cards. No series followed a regular sequence which would give the solution on some other basis than that intended.

2. "Presenting" a card consisted in placing it on the table

before the subject and keeping it concealed until the words "That was right" or "That was wrong" were spoken. The watch was started the moment the card was exposed and stopped as soon as the subject's pencil touched the paper in the overt reaction.

3. There were occasional irregularities. In five instances, the experimenter stopped the watch before the subject made the overt reaction. Two of these cases were due to the fact that the subject changed his mind after he had begun to mark the card. In the other three cases, the experimenter reacted before the proper stimulus occurred. On all these occasions, the reaction times were recorded as the registered number of seconds +.

4. Clues other than those involved in the constitution of a problem were sometimes given when a subject had worked for an hour or more on a problem without solving it. Sometimes the aid took a negative form, such as, "It has nothing to do with straight and curved lines" and sometimes a positive form, such as, "You were right in thinking that position is important." At other times it amounted to contributing an idea, such as, "Try using the concept of number," but in no case was the solution given outright. No person was aided in this way in more than two problems and every subject was permitted to go through at least one of his difficult problems with no aid whatever. All clues were recorded and the number of trials required for solution was stated as the obtained number of trials +.

5. Ten subjects were used in this experiment, five men and five women, all students in graduate courses in Psychology in Columbia University.

6. The subjects' reports perhaps require special comment. They were not introspections in the technical sense, since they constantly violated one of the fundamental rules of introspection in committing the stimulus error. The subjects really reported the objects they were noticing and thinking about and told how they were reacting to them; but since this was the very thing the experiment was trying to discover, reports were accepted in this form. However, this does not mean that no precautions were taken regarding the reports. They were safeguarded in definite ways.

(1) They were taken immediately *after* the overt reaction

and *before* the subject knew whether his reaction was right or wrong. This gave the subject little chance to forget what had happened or to rationalize it in the light of subsequent knowledge. He was able to catch himself in the midst of a course of thinking and determine the state of affairs at that point, while his view of the matter was still uninfluenced by knowledge he would acquire later.

(2) The reports were taken in response to questions which carefully avoided suggesting what the content should be. The instructions, "Will you tell me everything that went on in your mind from the time you saw the card to the time you marked it?" were chosen as encouraging thoroughness and at the same time suggesting nothing. This exact formula was used for the first three overt reactions in the introduction, was repeated at intervals throughout the problems solved on the first experimental day, and was used for the first overt reaction on each of the succeeding experimental days. At other times, the subjects were simply asked for their reports, though, after the first few reactions, they usually required no prompting but reported on their reactions as soon as they had performed them. The question "Anything else?" was asked at the conclusion of every report, so that it would become a matter of routine and serve as a stimulus to thoroughness, without suggesting that the experimenter thought there should be something more on any particular occasion.

V. *The Record*

The result of the procedure as a whole was a record containing the following items:

1. The cards, marked by the subjects, and arranged in the order in which they had been marked.

2. A series of reaction times, indicating the time of each separate trial and giving a reaction time curve for the problem as a whole.

3. The reports of the subjects, supplementing the objective records of the preceding items.

Distinctive Features of the Method

In the foregoing description, so much attention has been given to the details of the procedure, that its distinctive

features have probably been lost. For this reason, it may be advisable, before leaving the topic, to point out some of the special characteristics of the method.

1. The first is the fact that a definite attempt was made to keep the subjects as uninstructed as possible. The model, in this respect, was the animal experiment, where the mere presentation of the situation constitutes the task—or since human subjects were used, perhaps the comparison may better be made with the Yerkes multiple choice apparatus. During the experiment proper, no instructions were used which gave the subject the slightest indication of how he was to proceed. When clues were given, they were descriptions of situations, not directions as to how to respond. The only instructions which told the subject what to do were those used in the introductory exercise; and even these were non-specific and inapplicable to the problems of the actual experiment. In this way, the procedure escapes Watson's criticism that, in experiments on thinking, the results are prejudiced by the instructions—that the responses are not comparable with those obtained in animal experiments, where the situation, devoid of instructions, brings out whatever reactions appear.

2. A second feature of the method is the kind of objective record obtained. Several experiments on thinking, among them, Ruger's "Psychology of Efficiency,"[4] make a point of objective checks. In fact, the present study resembles Ruger's work in involving the solution of problems which are accompanied throughout by motor performances. But there are several ways in which it differs from Ruger's experiment as regards the motor side of the performance. First, the movements, in this case, leave permanent traces of their occurrence which become a part of the record. Much can be learned of a subject's activities from a mere examination of the cards he marked. In the second place, the movements are so simple and easy to perform that they probably give very little chance for lack of skill or faulty execution to obscure the subject's meaning. And finally, the fact that the motor activity is slight and insignificant in itself gives it a certain separateness from the thinking it represents. The thought and execution are not run together as in processes where motor

[4] Ruger, The Psychology of Efficiency, Archives of Psychology, No. 15.

manipulation plays a more intimate part. The thinking stands out cleanly from the overt activity and is the more observable on that account. And though, in this respect, the conditions are probably less like those of everyday life, they possess the distinct advantage, from the experimental point of view, of isolating the material to be studied.

3. A third characteristic of the experiment is an advantage which the material[5] itself possesses through its very artificiality and triviality. It does not call up a wealth of associations and bring large masses of knowledge into the problem. It reduces the situation almost to the level of nonsense as regards poverty of associations. This, like the reduction of the motor side of the performance, makes the thinking processes proper stand out clearly. The items of knowledge employed are limited and definite and their manipulation is relatively easy to follow.

4. The subjects' reports, too, present certain distinctive features. Some of these have been mentioned in describing the conditions under which they were obtained, but there are two points which deserve special mention. The first is the fact that the reports were made while the subject was actually in the midst of the problem. This is largely due to the fact that, objectively, the solution of a problem consisted in a series of overt motor reactions, and that by taking a report in connection with each performance, it was possible to get a current record of the process.[6] As was said before, in the case of each reaction, the subject gave his report before he knew whether he was right or wrong, and thus was enabled to present

[5] In the use of non-verbal material, this study resembles the experiments of Grünbaum and Westphal, though the tasks assigned by those experimenters were less strenuous. Grünbaum, Ueber die Abstraktion der Gleichheit; Arch. f.d. ges. Psychol., 1918, XII, p. 430. E. Westphal, Ueber Haupt-und Nebenaufgaben bei Reactionsversuchen: Arch. f.d. ges. Psychol. 1911, XXI, p. 233. Some of the difficulties inherent in the use of verbal "sense" material are implied in Bühler's discussion. K. Bühler, Tatsachen und Probleme zu einer Psychologie der Denkvorgange: Uber Gedanken. Arch. f.d. ges. Psychol., IX, 1907, pp. 303, 304.

[6] In many of the experiments on thinking, reports have been taken during the course of the process, by interrupting the subject at certain points and asking him to report his thinking as it then appeared. This device has been adopted by Messer, Ruger, Miss Fisher, and others. The present study differs from these in that the report is obtained not by an interruption but by an integral part of the procedure. Messer, Experimentelle-psychologische Untersuchung über des Denken; Arac. f.d. ges. Psychol., 1906, VIII, pp. 1-224. Ruger, op. cit. Fisher, The Process of Generalizing Abstraction: Psychol. Rev. Mon. Supp., 1916, XXI, No. 90.

the state of his thinking as he found it before he had any knowledge of its outcome. But more than this, each report represents not only a single reaction, but an event in a series of reactions. In consequence, it can be studied in relation to its setting. It is possible, therefore, to determine the status of an individual's thinking at any stage in the problem. The second distinctive feature of the reports is that they represent a definite attempt to utilize the stimulus error. This would be a fatal mistake if the purpose of the experiment were to analyze the process below the perceptual level—to discover, for example, whether thinking goes on in sensory or non-sensory terms. But it is assumed in this study that something can be learned of the process by observing it less minutely—by noticing to what stimuli the subject was reacting from moment to moment and what he was doing about them. Furthermore, this takes the task out of the sphere of those unfamiliar happenings which even the trained introspectionist finds it difficult to observe, and places it in the field of common-sense objects, where the well-practiced habits of everyday observation are an asset. Besides, it protects the results from Dodge's "apperception mass error" since the character of common sense objects is not affected by doctrines current in any particular laboratory. On the whole, while this practice limits observation to fairly obvious features, it keeps it in a realm where the results are definite and safe.

5. Finally, the systematic breaking of the problem into parts,[7] both as regards reports and manual reactions, gives a degree of exactness to the record which it would be difficult to attain if the whole process were examined at one time. In recounting a series of events it is notoriously hard to attain accuracy as regards temporal sequences and other relationships. But in this experiment, the sequence automatically records itself from reaction to reaction without requiring the subject to pay attention to that particular. The record evolves step by step with the process, so that the process is spread out for inspection as it occurs. Consequently, relationships of

[7] Hull's experiment is probably the best instance in which the thought process investigated was systematically broken into parts—a procedure which permitted the experimenter to use exact quantitative results. It was not a part of Hull's problem, however, to get reports of the process from the subjects. Hull, Quantitative Aspects of the Evolution of Concepts; Psychol., Rev. Mon. Supp., 1920, XXVIII, No. 123, pp. 9-22.

which the subject himself was not aware and which he did not report as such may be gained from an examination of the record. For example, the position of any event may be determined by locating the overt reaction in which it was reported. It then becomes possible to tell whether it occurred early or late in a problem, after a success or failure, and whether it preceded or followed some other event. This means that the subjects' reports can be treated in a more exact fashion than is sometimes possible in material of this sort.

CHAPTER II

Preliminary Survey of the Material

The kind of material that this procedure gives is illustrated in the following passages.[1]

PROBLEM A III[2]

1.—5.4 sec.—"I tried the top one, but I might as well have tried the other. I don't think it has anything to do with curves because we've had that." (Wrong)
2.—2.1 sec.—"I thought I'd try the bottom one then." (Right)
3.—2.1 sec.—"I thought I'd do the bottom one again since that was right, though there may be another factor involved." (Wrong)
4.—92.6 sec.—"Let me see. The last one was wrong when I marked the bottom one with straight lines. Therefore, I shouldn't mark the bottom one with straight lines. However, I shouldn't mark the top one, curved, because that's what I did the first time. So I marked the bottom one, curved. I didn't know what else to do and I haven't caught on a bit, and I did it hoping that it would bring out something. I'd like not to mark it, but that isn't your system." (Right)
5.—4.4 sec.—"I marked the bottom one, curved, again, because it was right last time, but I don't think I have the system yet." (Wrong)
6.—16.3 sec.—"I thought I'd try the one that had the most sides because the last time, when I marked the curved one at the bottom, it had only three sides and the diamond had four; and the other time I marked the curved one, it had the five-sided effect. I don't remember all of them, though." (Right)
7.—4.2 sec.—"I tried the same thing, marking the one with the greater number of sides." (Right)
8.—4.1 sec.—"That's the same thing." (Right)
9.—5.1 sec.—"Still trying greater number of sides." (Right)
10.—2.8 sec.—"Same." (Right)
11.—2.8 sec.—"Same." (Right)

Subject F.[3]

PROBLEM A IV

1.—7.2 sec.—"I thought I'd try the smaller number of sides and also the one that was whole, hoping to catch on to both of them at the same time." (Wrong)

[1] Three selections were made as fairly representative of the material. They are all unaided problems because, as will appear later, the presence of clues brought about special modifications in the subject's procedure. The first problem, A III, was chosen as representing rather simple, straightforward progress toward solution; the second, A IV, as involving more difficulty and complexity; and the third, A VI, as illustrating a problem in which no successes were possible before solution. No really long and difficult problems were included, because of lack of space.

[2] For the situation involved in each problem, and its solution, see Chapter I.

[3] The subjects are designated by letters of the alphabet. A, B, C, D, and E are women; F, G, H, J, and K are men. The letters have no reference to the subjects' names, but were assigned at random.

2.—7.8 sec.—"I thought I'd try the one that was cut into, incidentally the one with the larger number of sides, but I don't think that has any thing to do with it because you wouldn't give the same thing again." (Wrong)

3.—37.8 sec.—"I don't get the system. I don't know. I wonder if there is any difference in the term. I said cut into and I see that one might be regarded as superimposed. I'm wondering if one is larger than the other, but it doesn't seem to be. It may be, though. I marked the one that seems to have the smaller area because I couldn't think of anything else. (Wrong)

4.—39.2 sec.—"I couldn't make out what else it could be, because I've done right and left and superimposed and the one underneath, and number of sides, so I tried shifting the mark from the superimposed to the one underneath." (Wrong)

5.—13.3 sec.—"I decided that each time there was little difference in size. I have tried the smaller. I haven't tried the larger so I tried that this time." (Wrong)

6.—18.5 sec.—"I thought I'd try putting the sign of the under figure in the top one." (Right)

7.—5.1 sec.—"I tried the same. I'm not awfully sure that that's right. I feel I might have hit that by chance. It might be straight into curved." (Wrong)

8.—6.1 sec.—"I tried under into upper again because I think it was this way when I had it right, going straight into curved. No, wait a minute. I'm not sure about that, but when I put upper into under it was wrong, so I'll take a chance on this, under into upper." (Right)

9.—11.9 sec.—"I am doing straight into curved. It must be shifting the sign because that's what I did in both of those I had right. Oh! wait a minute. It must be straight into curve. Under into upper didn't hold of the one I had wrong and straight into curved was true of the two I did get right." (Wrong)

10.—39.7 sec.—"I am trying left into right now, chiefly because the last one was wrong. That means that straight into curved is wrong and upper into under is wrong, and under into upper, and the next thing I think of is right into left, and the last one was wrong, when I did left into right." (Wrong)

11.—19.1 sec.—"I keep trying to remember the way those two correct ones were and keep thinking I ought to be able to get something out of that. I can't remember very well, but I am now trying smaller number of sides into greater. It must be shifting the signs because that's what I did in the two I did get right." (Wrong)

12.—36.0 sec.—"I decided it can't be number of sides, because these have the same number of sides. I think I've tried everything I said I tried, but I feel now that I may have skipped one or made a mistake. I think I've tried upper into under and under into upper and curved into straight and straight into curved and left into right and right into left. Those two I had right were going in the same direction and I marked under into upper, so that's what I did here, but it can't be the right theory, because I've had some wrong that way I'm sure." (Right)

13.—143.5 sec.—"I thought at first I ought to be able to figure it out from the last one and the two others that were right. I also realized that all the theories I've tried are wrong. Then I wondered if it had something to do with the sign I make and it occurred to me that a circle and an angle are used in reading—the letter o and one of the diacritical marks, you know,—and the equal sign and multiplication sign in arithmetic, but I don't know what the little loop would be; it might be the letter e inverted. Anyway since I remember having one wrong when I made the equal sign, I thought I'd try the circle this time. I also felt relieved to admit that the other theories were wrong because I was tired trying them out." (Wrong)

14.—11.8 sec. "The time I did a triangle sign into a clover, it was right, so I am trying a triangle sign this time. Maybe it is when I make a mark with straight lines, but it can't be that because the equal sign was wrong." (Right)

15.—13.8 sec.—"I am trying the circle because the equal sign was wrong once before. I don't think it's that, though, because it seems to me that after the equal sign was wrong, I had the choice of that or the circle and it was wrong when I marked the circle." (Wrong)

16.—18.2 sec.—"Every time I've tried the triangle sign it has been right, so I tried the triangle sign again. I have another theory, too. It may be the place in the figure where I put the sign. I put both triangle signs up high, so I'm doing it again." (Right)

17.—9.8 sec.—"I don't think position has anything to do with it, really, because that's silly, but I tried it anyway, and I used the multiplication sign because the last time I tried the other one it was wrong." (Right)

18.—4.8 sec.—"Maybe it does have something to do with the top notch. Anyway it's safe. I used an equal sign, but I know it's been wrong before. I have a suspicion, too, that this is going in the opposite direction from the last two, from upper to lower. I still have that idea in my head." (Wrong)

19.—8.5 sec.—"I am trying lower to upper, up high." (Right)

20.—3.5 sec.—"Lower to upper, up high." (Wrong)

21.—35.5 sec.—"I know that's wrong. I marked it the same way, but I am completely out of ideas and couldn't think of a thing." (Right)

22.—13.8 sec.—"Isn't that funny? They are right sometimes when you do lower to upper. I don't think that's the reason at all. I don't see how it could be. But my triangle sign was a great help. It gave me a chance to use that, so I marked it the same way." (Wrong)

23.—37.8 sec.—"Oh! There goes my triangle sign. Now all my theories are gone. I've been thinking anyway that there is something I haven't caught on to, but just happen to hit once in a while. I've been wondering whether it had anything to do with the order of the signs when we learned them, but I don't think it would be that. That's the way I marked this, though. I think the e came earlier in the series than the equal sign." (Wrong)

24.—12.9 sec.—"This is going to be terrible. I'm not at all sure now that the e really came first. I'm doing the same theory this time. I think the triangle came before this star thing." (Right)

25.—33.8 sec.—"I have another theory. It just occurred to me that maybe you don't always shift the sign. Maybe when the upper is straight you give it its own sign. That's the way I did this one." (Wrong)

26.—8.4 sec.—"Then I think when the upper is straight, I'll mark the under one with its own sign." (Right)

27.—13.9 sec.—"Then that's it! Wait a minute. Let me see. Yes, when the under is curved, give it its own sign, when the upper is curved, give it the sign of the under. Now don't tell me that's wrong!" (Right)

28.—3.0 sec.—"At last! Under curved, give it its own sign.

29.—3.7 sec.—"Same." (Right)

30.—3.4 sec.—"Upper curved. Sign of other." (Right)

31.—4.3 sec.—"Upper curved. Same." (Right)

32.—3.3 sec.—"Under curved. Own sign." (Right)

Subject A.

PROBLEM A VI

1.—9.2 sec.—"I marked the one with the fewer sides. I took a chance that the little red thing meant reversing the principle we learned before for this arrangement. That's what the other little red thing meant last time." (Wrong)

2.—9.6 sec.—"Then I'll try greater number of sides." (Wrong)

3.—7.6 sec.—"I put the sign of the smaller number of signs inside the larger." (Wrong)

4.—2.2 sec.—"That's just the reverse of that principle." (Wrong)

5.—73.2 sec.—"I was just trying to think of everything it might be. It doesn't seem to be number of sides, and it couldn't be size because they are always about the same size. I was trying to see if position had anything to do with it. If the smaller number of sides is on top it might mean one thing, and if it's on the bottom, another. I marked top, smaller number of sides, on a chance." (Wrong)

6.—39.8 sec.—"I tried curves there. Curve, when it is on top and has larger number of sides. I guess that doesn't have a thing to do with it, though. But I marked the diamond once before and it was wrong and it would be foolish to mark it again." (Wrong)

7.—46.0 sec.—"It seems to me that this ought to mean the same thing the red mark did before, when we marked the straight figure because it was the opposite of the curve. I am marking the circle because it has the smaller number of sides, to give that principle another chance. Maybe I made a mistake in the sign or something when I did it before." (Wrong)

8.—43.2 sec.—"Wrong? This is simply bewildering. That red thing ought to have the same significance and I ought to be getting some of them right by chance. This gives you a terribly helpless feeling. You have nothing to go on. This is larger number of sides, curved, bottom. I may have tried that before." (Wrong)

9.—61.5 sec.—"I don't know how to do this, really. It's no use fooling around with position, number of sides, straight and curved lines and all those things when you have no lead. I just marked this to get it out of the way. It doesn't mean a thing. I have no ideas on the subject." (Wrong)

10.—5.6 sec.—"I just marked it. I can't think of a thing." (Wrong)

11.—4.2 sec.—"I think if I just keep marking and watching, I may catch on to something. I think you want something entirely new." (Wrong)

12.—3.8 sec.—"Just the same. No principle at all. Just hoping it will bring out something." (Wrong)

13.—3.3 sec.—"Same." (Wrong)

14.—4.1 sec.—"Same." (Wrong)

15.—5.4 sec.—"Same thing. But it isn't doing a bit of good." (Wrong)

16.—59.7 sec.—"I thought I'd try marking both of them. I kept thinking that it must be something entirely different because if it had anything to do with curves and number of sides and position and all those things I'd get some right by chance. I tried to dismiss all of them from my mind and the only thing left seemed to be to mark both, and if that's wrong, I'll mark both next time, but interchange the signs." (Right)

17.—7.6 sec.—"Oh really? Why that's the first thing I tried in the very first problem and I put the possibility out of my mind when it was wrong. Wasn't it stupid not to think of that before? But what a relief!" (Right)

18.—2.2 sec.—"Same thing. It gives you such a helpless feeling to keep getting them wrong. This is certainly a relief." (Right)

19.—2.1 sec.—"Same." (Right)

20.—3.4 sec.—"Same." (Right)

21.—2.2 sec.—"Same." (Right)

22.—2.6 sec.—"Same." (Right)

Subject E.

It is easy to see in a general way what happens when problems of this kind are solved. The subject keeps making one reaction after another until he finds something that gives success consistently. But obviously a general impression of this sort reveals little of the actual nature of the procedure. A closer inspection shows that the activity may be analyzed into a number of definite lines of conduct, each of which may be made a special object of study.

General Methods of Attacking a Problem; Participant and Spectator Behavior

Perhaps the first characteristic that strikes one in the specimens just presented is the general trial and error nature of the attack—the fact that the subject actively throws himself into the situation, trying one possibility after another, until the solution somehow emerges. In this respect, the specimens are representative of the mass of the material. When analyzed, this conduct is found to present two principal features.

The first is that the subject meets the situation by doing something definite about it. In connection with each overt reaction, he reports a hypothesis on which he is acting. The conditions require only that he mark the cards, but he responds in a more specific way[4]—he marks "the upper one," or "the bottom one when it is curved," or "the top figure with the sign of the other." He does not simply mark the cards at random. Every reaction represents a specific enterprise of his own.

The second is that the regular mode of response is to repeat the reaction if it is right and to change the hypothesis if it is wrong—in other words, to follow the usual trial and error procedure.

Given these two lines of conduct—the tendencies to respond with definite reactions and to repeat successes and avoid failures—the solution might conceivably be brought about by a simple process of "stamping in" and "stamping out." In

[4] This result is similar to that obtained by Messer, who found his subjects manifesting a tendency to make the task more specific than the instructions required. Messer, Experimentelle-psychologische Untersuchung über das Denken, Arch. f. d. ges. Psychol., 1906, 8, p. 22.

fact, there are occasional problems in which an approximation to this procedure actually happens. For example:

1.—9.2 sec.—"I thought 'I won't get caught marking both this time' so I put the sign in one. It might as well be one as the other, but I marked the right hand one." (Wrong)
2.—3.0 sec.—"I thought I'd try the left one then." (Right)
3.—4.2 sec.—"Tried the same thing again. The left one." (Right)
4.—3.2 sec.—"I marked the left one again." (Wrong)
5.—15.8 sec.—"I thought then I'd try marking the one with curves. It seems to me that the ones I've had right have been curved. But I can't remember back farther than the triangle, which was wrong." (Right)
6.—2.2 sec.—"I tried the curve theory again." (Right)
7.—6.2 sec.—"I am trying the curved lines again. I thought for a second 'They are not so much curved as the others,' but I tried it." (Right)
8.—3.2 sec.—"I stick to curves." (Right)
9.—3.3 sec.—"Curves." (Right)
10.—3.1 sec.—"Curves." (Right)

Subject J—Problem A II.

However, it is very seldom that a whole problem is carried through in terms of these regular tendencies. Usually, there are departures from the rule. The problems given at the beginning of the chapter are characteristic in this respect. Reactions 9, 13, and 25 in Problem A IV show that successes are not always repeated and Reactions 8, 21, and 24 in the same problem show that failures do not always lead to changed reactions. They also suggest some of the reasons why departures from the rule are made. But at present the fact that exceptions occur is the essential point, not the reasons for their occurrence.

Since it is based on the tendency to meet a situation with a definite enterprise, this general method of attack will be referred to as "participant behavior." The tendencies to repeat successes and avoid failures will be called the "regular" forms of the response; and departures from the rule involving either changes after succcesses or repetitions of failures will be spoken of as its "irregular" forms.

But participant behavior is not the only method of attacking a problem. The subject does not always go halfway to meet the situation. Sometimes he withdraws from active participation, marking the cards in compliance with the demands of the procedure, but in such a way that the reaction in itself "means nothing." At least it represents no hypothesis which is being tried out. Reactions 9-15 inclusive in Problem

A VI illustrate this kind of conduct, which in contrast with the general method just described, will be called "spectator behavior."

Spectator behavior exists in three forms. The kind illustrated above may be called its "primary" form. It is distinguished principally by the fact that the overt reaction is accompanied by no hypothesis—usually because the subject can think of none; and obviously where the response has no definite content, the tendency to repeat successes and avoid failures is automatically thrown out of operation. But this conduct does not mean that the subject is doing nothing. There are usually indications that a general observational activity is occurring—or rather, that the organism is set for registering impressions not specifically attended to. As a rule, somewhere during the course of a series of spectator responses, the subject expresses himself as hoping that they will "bring out something" if he keeps "marking and watching."

A "secondary" form of spectator activity is somewhat more sophisticated. The subject is more definitely aware of what is going on and makes an attempt to focus his observations. He adopts a hypothesis which he knows is wrong, but usually one which has given some success, trying to observe the circumstances in which it is right and those in which it is wrong, and in that way, to get a clue to the situation. The following passage illustrates this kind of activity.

7.—10.8 sec.—"Here I am trying another tack. I realize that I can't remember all the back ones, so I am going to try to mark the lower ones for several times to see if I can get a principle. The lower ones have been right sometimes. I am saying to myself lower straight, curve on top, so that I'll recognize the same kind of situation if it comes around again and maybe I'll find out when they are right and when they are wrong." (Wrong)
8.—6.2 sec.—"I am keeping on with that idea." (Wrong)
9.—4.2 sec.—"Same thing." (Right)
10.—5.0 sec.—"Same." (Wrong)
11.—4.8 sec.—"Same." (Wrong)
12.—3.5 sec.—"Same, but I'm forgetting all those things and I'm not catching on." (Right)
13.—3.7 sec.—"Same."

Subject D—Problem A III.

There is also a "momentary" form of spectator behavior, which occurs when the subject falls into this method for a single reaction. For example:

47.—14.5 sec.—"That doesn't mean a thing. I just marked it any way. I am confused terribly and couldn't think of anything. I keep wondering why one figure is always so much larger than the other and was trying to connect that with the situation in some way. That's what I was really thinking about."

Subject E—Problem B II.

As this illustration shows, the subject may become absorbed in an activity not directly connected with the overt reaction and, as a result, the two lines of conduct become temporarily dissociated. This condition is typical of spectator behavior in general in the sense that the overt activity does not represent the main activity of the moment.

The first result of a preliminary survey, then, is to show that there are two general methods of responding to a problem—participant and spectator behavior.

Detailed Operations on the Materials of Thinking

Within the setting of the general activities just indicated there are more detailed processes at work. The materials used in thinking are not always complete hypotheses, and the processes by which they are manipulated are not limited to the relatively simple reactions involved in repeating and avoiding these comparatively large units of behavior. The material with which a subject is dealing is constantly undergoing more minute operations.

In the first place, it is being broken into parts. In this experiment, any process by which the content of a reaction is divided into smaller units will be called analysis. Reactions 4 and 6 in Problem A III, Reactions 3, 9, 12, 13, and 25 in Problem A IV, and Reactions 5 and 6 in Problem A VI, among others, illustrate analysis in showing that the subject does not take the total situation as an undifferentiated mass, but reacts to discrete part of the whole. Some of the more elaborate forms of analysis occur in problems in which sample cards are presented with the first situation. For example:

1.—37.6 sec.—"First I noticed the double lines and thought that ought to have something to do with it, but I noticed that one of the double figures was marked and the other wasn't, so I didn't get anything out of that. Then I started thinking about curves and noticed that both marked ones were curved, but I knew it wouldn't be just marking the curve because we've had that and that would be too easy. Besides that didn't do anything with the double lines and I felt that they ought to come in somewhere. Then I noticed that one of the curves was marked

with the sign of the other figure and all of a sudden I thought that if the curve had double lines you gave it its own sign and if not you gave it the sign of the other figure. That's the way I marked this one; but I'm not awfully sure that's right because now I see that both marked ones are on the left, so it might be marking the ones on the left. Oh! Always put the sign of the double figure inside the one on the left—or maybe inside the one that's curved. This one that I've marked will bring that out because I marked the curve and it's on the right. I mean it will show whether it's the curved figure or left figure that gets the mark. I'm pretty sure you use the mark of the double figure."

Subject A—Problem C IV.

Another event that is constantly occurring is that different parts of the situation are being brought together. Any process which brings about this result will be referred to as a process of synthesis. The passages suggested as illustrations of analysis are also illustrative of synthesis since they show that reactions acquired in other problems or in other parts of the same problem are brought to bear on the situation in question. More obvious cases of bringing in material from other problems are found in the following reactions:

1.—18.4 sec.—"Well, I noticed the little red star and didn't think it would be there for nothing. And the old principle I learned for this arrangement was marking the figure with curved lines. So I put the star in the figure with curved lines because that would use both."

Subject E—Problem A IV.

1.—56.8 sec.—"Simply an effort to work out some plan to include something done before as well as one of these suggestions. I rejected the first sample because two marks are called for and previously only one has been used. I rejected the second because the marking is against everything formerly done. The equal sign doesn't belong with either of those figures. Either the third or fourth might be all right because they both use signs belonging to those figures. I took the fourth because placing the mark inside the figure is more like what we've had. As soon as I marked it, a low degree of confidence. I think I should have used the third, because it is enough like the old ones to belong, and yet it's different and I notice that each problem has some new feature. I'm set to mark it like the third next time."

Subject H—Problem D II.

Material is also being discarded from time to time. When reactions are associated with failure, they are likely to be avoided—sometimes deliberately discarded and sometimes merely dropped out. The regular avoiding of incorrect hypotheses is one illustration of this activity and Reactions 1 and 4 in Problem A III, Reactions 10, 12, 13, and 23 in Problem A IV, and Reaction 5 in Problem A VI illustrate the more overt acts of dismissal. A series of unsuccessful reactions

often results in a "blank" feeling in which the subject reports that he can think of nothing to do. This effect is shown in Problem A VI above, where in Reaction 9 the subject was evidently in this condition. Sometimes the discarding of old hypotheses practically amounts to beginning the problem anew. For example:

8.—16.2 sec.—"Well, this is where we begin over again. If that was wrong, none of those ideas about the position of the curved figure to the right or left are any good. All my theories are gone. This time I marked the curve with the symbol of the larger number of sides."

Subject H—Problem A IV.

The natural result of the discarding activities would be to produce a mental vacuum, but this tendency is counteracted by a set of processes which tend to supply new material. Problem A IV is a particularly good illustration of the way in which new responses appear in the situation as old ones prove useless. In the course of this problem, the subject evolved six distinctly new lines of attack, in addition to using variations of the old ideas of straight and curved lines, number of sides and the position and size of the figures. The reactions involved in shifting the sign from one figure to another, classifying the signs as associated with reading or arithmetic, placing the sign high in the figure, regarding particular signs as having special value, following the sequence in which the signs were first given, and dividing the situations into classes which required shifting the sign and those which did not, all appeared for the first time during this problem.

Other illustrations of new responses are the following:

23.—23.2 sec.—"I marked the one with an even number of lines and next time I am going to try an odd number of lines. I couldn't think of anything for a while and then it suddenly came to me that it might be that."

Subject C—Problem A VI.

10.—17.6 sec.—"I tried that because I thought it might be the ones with the rounded lines. I think the ones I've had right when I marked them on the left hand side had rounded lines. I think they have but I'm not sure."

Subject E—Problem A II.

Thus the second general fact brought out by a preliminary survey is that thinking involves a number of detailed operations resulting in analysis, synthesis, and the discarding and supplying of content.

The Organization of the Materials of Thinking

A third point is that the material with which a subject is dealing is never completely unorganized. From the beginning, it is present not as an undifferentiated mass, but in forms which seem fairly regular and stable.

In connection with a single, overt reaction, content may appear in any or all of the following forms:

1. As the hypothesis acted on.

The term "hypothesis" is used throughout this study to denote the subject's statement of what he was attempting when he made his overt reaction—for example, "I marked the one on the left," or "I did the same thing again," or "I think that in any case you mark the bottom one; if it is incomplete, you mark it with its own sign; if complete, with the sign of the other." The hypothesis may be simple or complex, but it functions as a unit—usually as the most important unit from the subject's point of view.

2. As a hypothesis entertained but not acted on.

Sometimes, the subject formulates possibilities of action in addition to the one he is trying out. A possibility which functions as a secondary hypothesis in one reaction may or may not become the basis of action in subsequent reactions. The following response shows the presence of several secondary hypotheses.

1.—7.0 sec.—"I marked the one with the greater number of sides, but there must be more to it than that. I might as well have tried something different. It's probably greater number of sides into less, or it may be less into greater, or greater number of sides into the bottom one, or into the curved one, or it may be the reverse of any of those."

Subject A—Problem A VI.

3. As an observation or speculation.

Content may be present without being included in an hypothesis, either primary or secondary. Detached observations and speculations sometimes appear and are apparently unutilized at the time. For example:

7.—8.2 sec.—"I marked the curve again. I noticed that the diamond was almost a square."

Subject C—Problem A II.

10.—7.9 sec.—"I decided to try that marking when the curve is above —interchanging the signs. After marking it, I wondered if there might be some new way of classifying the figures, something that hasn't been used before."

Subject F—Problem A III.

Observations and speculations of this sort may be used in hypotheses eventually, but sometimes they disappear without producing any apparent effect.

4. As considerations or reasons for action.

A fourth kind of content differs from the others in that it does not and can not furnish a formula of action. It includes considerations or reasons for action, which apparently stress certain ways of reacting and give them the preference over other possibilities.

1.—8.3 sec.—"I thought, 'Shall I mark one or both?' Then I thought it was a little smarter to mark both since I knew both, so that's what I did."

Subject A—Problem A I.

33.—17.2 sec.—"It may be that there is a certain order you have decided on that we have to find and mark them in that order regardless of everything else. Oh, it couldn't be that! Nobody would be mean enough to expect us to do that."

Subject J—Problem B II.

18.—52.4 sec.—"I thought it might have something to do with their sequence the first time they came, but I decided against it because that would make it too much like memory and I have an idea that memory isn't the point of the experiment. I marked upper straight, to see if that would show up anything."

Subject G—Problem A III.

In connection with a given overt reaction, content may occur in any or all of these four forms. It may be present in any combination of these forms and, with the exception of "considerations" and "reasons," any form may appear by itself. The most common arrangement consists in a statement of the primary hypothesis, plus some supplementary material; but even the primary hypothesis is not always present, as the occurrence of spectator behavior shows. Besides, the absence of a primary hypothesis does not preclude the presence of other forms of content. As in the following illustration, there may be a large supply of material on hand, but none of it may be used in a hypothesis.

9.—21.9 sec.—"It is rather difficult to tell just what I was trying to do. I didn't do anything, really. I thought of marking the circle and then didn't mark that, possibly because I had been marking the left one, though I don't feel that's the proper criterion. I recall the last time a maltese cross came, it was on the right hand side and almost covered. In that case, there was a shamrock on the left. I also began speculating about number of lines about that time. It all seems quite aimless."

Subject H—Problem A IV.

But not only is the material organized within a single reaction, there is a certain organization within a problem as a whole. It is difficult, in a few illustrations, to bring out differences in orientation toward problems as total situations; but if a comparison is made between the unaided problems given at the beginning of the chapter and the aided problems given below, it will become apparent that the line of attack is different in problems with and without clues. Here the contrast appears principally in the manner in which the two kinds of problems are approached in the first reactions—the haphazard attack upon the unaided problems as compared with the careful investigation of the aided situations. This and other differences which appear when other kinds of problems are considered, suggest that the orientation toward a situation as a whole is a topic worthy of further examination.

PROBLEM C V

1.—120.2 sec.—"I thought I might as well be systematic about this, so first I looked to see which figure the insert belonged to and saw that in both correct samples, they belong to the little figures. Then I noticed that in one of them the little figure had its own mark and in the other the big figure was marked. I think maybe that's the first thing I noticed. I thought it wouldn't have anything to do with the straight-line curved-line idea because one of the samples has two straight line figures and next I started thinking about number of sides and while I was thinking about that, the idea came to me that if the little figure has the smaller number of sides you give it its own sign, and if not, you put its sign in the other figure." (Right)
2.—8.0 sec.—"I did the same thing. This time the little one gets its own sign." (Right)
3.—3.2 sec.—"Same." (Right)
4.—4.6 sec.—"Same." (Right)
5.—5.2 sec.—"Same." (Right)
6.—4.1 sec.—"Same." (Right)

Subject G.

PROBLEM B I

1.—22.4 sec.—"Well, I just looked to see how the principles could be applied and marked the inner curved figure because it fulfils both conditions. But it is so obvious that I suppose it is incorrect." (Right)
2.—4.5 sec.—"Inner curve. But I'm looking for a catch." (Right)
3.—4.9 sec.—"Same. The catch is yet to come." (Right)
4.—5.1 sec.—"Same." (Right)
5.—3.1 sec.—"Same." (Right)
6.—18.2 sec.—"Here's the catch. The question is whether it is to be inner or curved since it can't be both. I'll try the inner first." (Wrong)
7.—5.8 sec.—"Then it must be curves." (Right)
8.—4.6 sec.—"Curves." (Right)
9.—4.7 sec.—"Curves. Inner as well as curved this time." (Right)
10.—4.0 sec.—"Curves." (Right)
11.—4.0 sec.—"Curves." (Right)

Subject H.

The Solution of a Problem

A fourth point which a preliminary survey suggests as a profitable object of study is the reaction in which the solution occurs. In a sense, the solution is the goal of all the processes involved in thinking. On the basis of general impression, it is one of the outstanding events in the course of a problem and for that reason affords a definite point of attack. It may be investigated to see whether it is marked by characteristics which distinguish it from other reactions—whether it is regularly accompanied by particular modes of behavior, or whether there are any processes which are especially likely to bring it about.

The Problem as a Complete Train of Thought

Finally, instead of taking particular aspects of the thinking activities separately, it is possible to study each problem as a unit. The experiment provides 180 specimens of thinking, each of which represents a complete course of thought. That is, each specimen begins with a problem-situation, continues until the situation is satisfactorily met, and in the meantime exhibits the activities involved in bringing about that result. It is possible, therefore, to study each complete train of thought as a unit, and analyze it to see whether there is any process, or set of processes, or series of events, regularly and necessarily involved in the solution of a problem.

Summary

This general inspection of the material practically amounts to setting the problems of the investigation. The following list is given as constituting at the same time a summary of the results of a preliminary survey and a statement of the particular problems to be studied.

1. Two general methods of meeting a problem, participant and spectator behavior.
2. Four classes of detailed operations on the materials of thinking—processes resulting in analysis, synthesis, and the discarding and supplying of content.

3. The organization of the responses involved in thinking, both from the standpoint of the separate reaction and of the problem as a whole.

4. The solution of a problem.

5. The problem as a complete train of thought.

CHAPTER III

The Objective Validity of the Results

There are two reasons why the material which this experiment provides may be considered lacking in objective validity.

In the first place, the method is one which, by its very nature, leaves part of the organization of the results to the judgment of the experimenter. The procedure is not one which automatically sorts its data into classes representing pros and cons on a particular proposition. In fact, it is not designed to test a particular proposition: the problem is exploratory and observational. It consists largely in gathering a certain kind of material and analyzing the special features it presents. But the selection of significant features is determined in part by subjective factors which may possibly influence the results.

In the second place, one part of the record, the subjects' reports, is not perfectly objective. What guarantee is there that the interpretation of these reports represents anything but a personal opinion? If several individuals examined the same material, would they find the same things in it? Would there be agreement among a number of competent judges, or would the interpretation in each case be purely an individual matter?

The first of these points is the less objectionable of the two. For after all, selection and organization always involve subjective factors and the difference between their operation in a proposition-testing experiment and in an exploratory study is largely an affair of time. In the one case, the experimenter selects his problem and organizes his material *before* the experimental procedure is begun. He points his experiment at a particular fact or set of facts and arranges it so that it will bring out the relevant evidence. The subjective factors, whatever they may be, go into the preliminary analysis which shapes the experiment. In the other case, the experimenter does not know until he has gathered his material, what special features it will present. He therefore, has the problem of selection and organization *after* the data are in. Of course,

another person, analyzing the same material, might choose other features as significant—just as several individuals attacking the same general problem with the other type of experiment, might choose different aspects of the question to investigate. Selecting significant features on the basis of observation is nothing more than selecting problems to be attacked; and in the selection of a problem, the presence of subjective factors is neither avoidable nor objectionable.

The objection to subjective factors would be justified, however, if the interest which determined the selection determined the emphasis—if interest in some aspects of the situation gave them undue prominence at the expense of others. But results may be protected from this kind of distortion by the simple device of counting cases. By enumerating the instances in which a given fact occurred, quantitative checks may be made upon uncensored impressions. Thus, the first objection to the role of subjective factors disappears as soon as it is analyzed. Subjective factors, when they figure in the selection of problems, can hardly be considered harmful; and when they may become harmful by leading to false emphasis, they may be counteracted by quantitative statements of results.

However, the second point is still to be considered. If the interpretation of the subjects' reports is only a personal opinion, the mere fact that the analysis is stated in quantitative terms will not give the results objective validity. Fortunately, this is a matter which can be submitted to an empirical test by determining the amount of agreement in interpretation actually obtained among a number of competent observers.

In order to test this point, four persons besides the experimenter were asked to examine portions of the record and to indicate the presence of certain items which the experimenter had chosen as objects to be studied. All the individuals who acted as judges were graduate students in Psychology in Columbia University and none of them had served as subject in the experiment. They were asked to work independently of each other and of the experimenter, and in order that they might do so, were given their instructions in written form.

Since it was impracticable to have the judges analyze the entire record, or even to identify all the significant features

in a small part of it, certain items were selected as representative of the facts to be observed, and the judges were supplied with portions of the subjects' reports in which the experimenter thought those items could be found.

The following tasks were chosen as constituting a fair sample of the kind of analysis the experimenter would have to make.

1. The identification of the hypothesis on which the subject acted in each overt reaction.
2. The identification of hypotheses entertained but not acted on.
3. The identification of a particular "object of thought"—straight and curved lines, for instance—in any form in which it appeared, whether as a hypothesis acted on or merely entertained, or as an observation, speculation, or reason for acting. Practically, this task amounted to tracing a given idea through a series of reactions.
4. The identification of reactions of two sorts: (a) those in which the subject expressed a plan or intention regarding his future activity; and (b) those in which the subject actually carried out a plan or intention which he had stated.

The first two tasks could be performed by treating each overt reaction as a separate unit, but the remaining two required the judges to follow the subject's activity through a series of several reactions.

In connection with these tasks, the judges were given all the material the experimenter would have in making the analysis—complete copies of the record including facsimiles of the cards marked by the subjects. The items to be identified were defined as precisely as possible and the instructions were as minute and definite as they could be made. The judges were given a code by means of which the several items could be indicated and, by way of illustration, were provided with sample passages marked by the experimenter according to the code. In this way, a definite attempt was made to make the task exactly the same for all the judges, since the point of the investigation was to find out how much agreement there would be in locating items previously selected and defined, not in selecting important items or in defining the items selected.

Different parts of the record were assigned for each task in order to get material suitable to the purpose in each case. The use of material suitable to the purpose does not mean the selection of passages in which the specified items were particularly obvious; on the contrary, it means that an attempt was made to get specimens which were representative of the mass of the material in difficulty. For this reason, two passages were used for each of the tasks—an easy one and a hard one. The easy one consisted of an extract in which, according to the experimenter's opinion, the objects sought stood out with a fair degree of distinctness; the hard one was a passage in which the items in question were embedded in material which might cause confusion. There were, therefore, eight extracts passed on in all, two for each of the four tasks. Each passage represented the report of a single subject, but the eight passages represented the reports of eight subjects. Each judge, of course, passed on the same portions of the record as all the rest. Finally, most of the passages included some sections in which the specified item was absent, so that if the judges were suggestible to the extent of supposing that it must be present in connection with every overt reaction, that fact would also be registered.

There are several ways in which the results of this study might be treated, but for the present purpose, the important point is to find out to what extent the judges agreed with the experimenter in their interpretations. This fact is brought out by comparing the number of agreeing judgments with the number of disagreeing judgments and computing the percentage of agreement on that basis.

However, a difficulty immediately arises in determining the number of possible objects of agreement. Materials which might act as confusion stimuli were present throughout the passages analyzed, and the question naturally arises as to whether or not confusion stimuli are to be considered possible objects of agreement. If so, the ignoring of some items must be taken into account as well as the identification of others; and since agreement may be shown in refusing as well as in accepting cases, this seems a reasonable procedure. But which of the many extraneous items are to be considered possible confusion stimuli? Which ones are sufficiently like the specified item to be confused with it? This difficulty was

met by regarding as confusion stimuli only those items to which any judge or judges actually reacted as if they were the objects defined. Possible objects of agreement, therefore, include all items to which any identifying response was made; a judge may agree with the experimenter either by identifying objects which the experimenter identified or by failing to identify objects which the experimenter did not identify, but which nevertheless aroused the identifying response in one or more of the other judges. This method does not give a perfect measure of agreement, but it probably errs on the side of caution, in that it may omit confusion stimuli which all subjects avoided and which, if included, would count as cases of perfect agreement.

On this basis the following table was prepared to show the amount of agreement with the experimenter's judgments on the various classes of items. The first column gives the total number of chances of agreement on the item in question—i.e., the number of possible objects of agreement multiplied by

	Chances for Agreement	*Number of Agreements*	*Percentage of Agreement for Each Section*	*Percentage of Agreement for Each Task*
Task I (Hypotheses Acted on)				
Easy Section	28	28	100	100
Hard Section	28	28	100	
Task II (Hypotheses Entertained)				
Easy Section	60	60	100	98
Hard Section	28	26	93	
Task III (Content of Thought)				
Easy Section	68	65	96	95
Hard Section	96	90	94	
Task IV				
a (Plans for the Future)				
Easy Section	24	24	100	98
Hard Section	60	58	97	
b (Plans carried out)				
Easy Section	20	19	95	87
Hard Section	52	44	85	
Total	464	442		

Percentage of judgments in agreement with experimenter's judgments = 95.

the number of judges. The second column gives the number of agreements which actually occurred. The third column gives the percentage of agreement for the hard and easy parts of each task. The fourth column gives the percentage of agreement for each class of items, regardless of their classification as hard or easy tasks.

The principal fact brought out by this table is that the percentage of agreement is high, both for the separate tasks and for the data as a whole. Another fact which appears is that the amount of agreement varies from task to task though the variation is on the whole rather slight. The greatest agreement was obtained in identifying hypotheses on which the subjects acted—a result which would be expected both because objective checks were available in this case and because the subjects usually centered their attention on this point in reporting their reactions. The greatest disagreement occurred where the judges were required to decide whether or not the subject was acting according to a previously formulated plan; but even here, where the task seemed most difficult, the percentage of agreement is not low. On the whole, the results very definitely bring out the fact that the analysis made by one individual is more than mere opinion.

The degree of agreement becomes even more apparent when certain facts, not directly revealed by the table, are brought to light. In the first place, there were 100 of the 116 items on which agreement with the experimenter was perfect and there was no case in which the experimenter's judgment was not upheld by at least two of the four judges. In the second place, most of the disagreeing judgments were responses to confusion stimuli. To be exact, 17 of the 22 cases of disagreement were responses to the 11 confusion stimuli in the experiment. Of the 105 instances in which the experimenter positively identified an item as belonging to a certain class, there were only 5 disagreeing judgments expressed by the four other judges all together. Of all the possible confusion stimuli present in the passages reviewed by the judges, there were only 11 which were judged as belonging to any class contrary to the judgment of the experimenter, and none of these was so judged by more than two of the judges.

In conclusion, the role of subjective factors may be summarized in the following way. In the preliminary organi-

zation of the material and the selection of features to be studied, subjective interests are admittedly present; different individuals, confronted with the same material, would doubtless find different problems to investigate. But after certain features have been selected as important, they may, if they are submitted to quantitative study, be protected from the possible distortions of personal interests. And finally, the interpretation of the subjects' reports is found to approximate objective validity. These reports, the least objective results of the experiment, are material on which different observers can and do agree.

CHAPTER IV

Participant Behavior

The tendency at present, both in experimental work and in theory, is to approach the subject of thinking from the point of view of trial and error.[1] In a sense, the study of participant behavior, as it appears in this experiment, is a study of the role of trial and error in thinking. The attack upon the situation with one hypothesis after another is essentially a trial and error attack; the regular tendencies to avoid failures and repeat successes suggest "stamping in" and "dropping out"; and the irregular forms or departures from strict trial and error, show how the more primitive process is modified when it occurs at the thinking level.

The Distribution of Participant Responses

Something of the nature of the processes involved may be shown by their mere distribution. The principal facts are presented in the following tables,[2] in which, for the sake of

	Participant Responses				*Spectator Responses*
	Regular		*Irregular*		
Subjects	*CF*	*RS*	*CS*	*RF*	
A	75	30	27	9	16
B	122	39	18	18	24
C	69	42	17	7	1
D	68	54	22	14	31
E	95	41	22	18	29
F	80	31	43	8	29
G	69	39	24	6	0
H	94	43	25	10	20
J	90	36	26	12	74
K	55	31	17	6	174
Total	817	386	241	108	398

[1] Naturally the behavioristic view regards thinking as basically trial and error. An illustration of the kind of discussion this view has aroused is the symposium "Is Thinking Merely the Action of Language Mechanism?" British J. of Psychol., 11, 1920-21, pp. 55-104.

[2] Not all the reactions of the experiment are included in these tables. All together, there were 3021 reactions. 891 of these were excluded from this particular study, because they occurred after the solution of a problem, and the 180 first reactions to problems could not be included because they followed neither successes nor failures.

comparison, spectator as well as participant responses are included. In the first table, the distribution is made according to individuals; in the second, according to problems. In both, the first four columns represent participant behavior, and the fifth, the spectator response. The first two columns give the regular forms of participant behavior—changes after failures (C. F.) and repetitions of successes (R. S.); the next two the irregular forms—changes after successes (C. S.) and repetitions of failures (R. F.).

	Participant Responses				*Spectator Responses*
	Regular		*Irregular*		
Problems	*CF*	*RS*	*CS*	*RF*	
A I	69	0	0	17	2
A II	34	24	2	10	85
A III	82	51	32	16	78
A IV	118	64	46	9	46
A V	29	4	5	3	2
A VI	116	0	0	6	29
B I	12	37	9	2	0
B II	91	59	31	8	58
B III	11	46	19	3	6
C I	20	18	20	1	62
C II	29	21	7	13	19
C III	10	2	6	1	0
C IV	31	24	18	10	0
C V	25	3	13	1	0
D I	24	15	6	5	9
D II	20	0	0	1	0
E I	42	15	15	2	0
E II	54	3	12	0	2
Total	817	386	241	108	398

The general fact brought out by these tables is the great frequency of participant as compared with spectator behavior. Its superiority appears both in absolute numbers and in the wide range of its distribution. On the basis of totals, participant behavior includes 80 per cent of all cases, leaving spectator behavior only 20 per cent. And not only does the participant attitude occur in all subjects and in all problems; in most cases it receives a decided preference. In 9 out of 10 individuals and in 16 out of 18 problems, its frequency is at least twice that of spectator responses.

A second point is that participant behavior is not particu-

larly influenced by individual differences. All the subjects used it and used it in the same way. With two exceptions, the frequencies of the four classes follow the same order for all individuals, the order being that in which the classes are arranged from left to right in the tables. In contrast, the spectator attitude varies widely from individual to individual. One subject did not use it at all; another used it more extensively than all the other responses together. In one subject it ranks second, as compared with other classes; in others, third; and in still others, fourth and fifth.

Similarly, participant behavior is not greatly affected by differences in problems, though the spectator responses show considerable variation in this respect. There is no problem in the experiment in which participant behavior is not used, but there are 6 of the 18 problems from which spectator responses are totally absent. Again, within the general class of participant responses, the distribution among the subclasses is fairly uniform. In every problem, the regular responses outnumber the irregular. However, the four separate classes do not maintain their rank from problem to problem with the same uniformity as when the distribution is made according to individuals. It is possible that this increased variability may represent a genuine fact that the situation is more potent than the individual in determining the response. But it may mean only that the classes are smaller when the cases are divided among 18 problems rather than among 10 individuals; that, in consequence, the frequencies represent the situation less adequately; and that exceptions to the rule are given greater relative weight. At present, it is impossible to decide between the alternatives. But in spite of this fact, the general result is clear that there is no problem in the experiment in which participant behavior does not occur and that it displays essentially the same characteristics in all problems.

A fourth point, really implied in the last two, is that some of the tendencies involved in participant behavior are more firmly established than others. From every point of view, the tendencies to regular responses are stronger and more uniform than the tendencies to irregular ones; in every problem and in every individual, the sum of changes after failures and repetitions after successes is greater than the sum of the

other two classes. In most cases, too, from the standpoint of frequency, the tendency to avoid failures seems greater than the tendency to repeat successes, but since chance does not give an equal number of successes and failures, the frequencies

	Responses to Success		*Responses to Failure*	
Subjects	*RS*	*CS*	*CF*	*RF*
A	53%	47%	89%	11%
B	68	32	87	13
C	71	29	91	9
D	71	29	83	17
E	65	35	84	16
F	42	58	91	9
G	62	38	92	8
H	63	37	90	10
J	58	42	88	12
K	65	35	90	10
Average %	62	38	89	11

	Responses to Success		*Responses to Failure*	
Problems	*RS*	*CS*	*CF*	*RF*
A I	%	%	80%	20%
A II	92	8	77	23
A III	61	39	84	16
A IV	58	42	93	7
A V	44	56	91	9
A VI			95	5
B I	80	20	86	14
B II	66	34	92	8
B III	71	29	79	21
C I	47	53	95	5
C II	75	25	69	31
C III	25	75	91	9
C IV	57	43	64	36
C V	19	81	96	4
D I	71	29	83	17
D II			95	5
E I	50	50	95	5
E II	20	80	100	0
Average %	56	44	87	13

are not comparable as they stand. The real question is, out of all the failures encountered, in what *percentage* of cases did the subject change his reaction? In what *percentage* of all the successes achieved, did repetitions actually occur? In

order to answer these questions, the frequencies are reduced to percentages in the accompanying tables, and a different arrangement of classes is used. The reactions are not classified as regular or irregular, but as responses to success or failure.

These tables confirm the impression given by the raw frequencies that the tendency to avoid failures is stronger than the tendency to repeat successes. The result is absolutely uniform for individuals and holds in 16 of the 18 problems. Another point is that the response to failure is much less variable than the response to success, both for individuals and for problems. In fact, the table suggests that, as regards both successes and failures, the response is more variable from problem to problem than from individual to individual; but again, the apparent variability may be due to a difference in the number of cases rather than to the direct influence of the problems themselves. Still, the variability of the response to success is plainly greater than that of the response to failure, whether the classification is made acording to individuals or problems.

Thus, the mere distribution of participant behavior brings out several definite facts.

1. In the first place, several lines of evidence suggest that participant behavior is a fundamental, deeply rooted activity —a state of affairs which would be expected according to current views on trial and error in thinking. Certainly it is a far more common response than spectator behavior, both from the standpoint of absolute frequency and from the range and inclusiveness of its distribution. As an actual matter of experience, it is found to be indispensable to all individuals and to all problems. Besides, differences in individuals and problems do not greatly affect its character— another fact which marks it as a well established and fundamental mode of behavior.

2. In the second place, the distribution shows something of the relative strength of its component tendencies. It is evident that its regular forms—the tendencies to avoid failures and repeat successes—have a stronger hold on the organism than the irregular; that is, within the general field of participant behavior, the tendencies that correspond most closely to simple trial and error have a distinct advantage. The analysis also shows that of these two regular trial and

error activities, the tendency to avoid failures is the stronger.

3. In the third place, there is an indication of a definite, yet flexible, organization of response. The fact that the distribution among the four classes is similar in the majority of cases indicates the presence of something like a pattern of behavior, sufficiently regular to make itself felt in spite of differences in individuals and in problems. Incidentally, this is one of the indications that the response as a whole is well established. Yet the fact that even the strongest tendency sometimes gives way to a tendency working in the opposite direction shows that the pattern is not rigidly fixed.

The Subjects' Reports on Participant Responses

More detailed knowledge regarding participant behavior may be gained from the subjects' reports. This source of information is most useful in disclosing the conditions in which the various forms of the response occur—particularly in explaining the circumstances in which departures from pure trial and error are made.

The first significant feature of the reports, from this point of view, is that so long as the subjects are avoiding failures and repeating successes, they say nothing about it; but that when they are departing from the rule, they explain the circumstances. This conduct is an interesting confirmation of one of the facts brought out by the distribution. The tendencies which appear strongest according to that analysis are the ones which the subjects themselves take for granted—as if they were modes of behavior so thoroughly established that they escaped comment and even attention. Of course this feature of the reports is not absolutely without exception, but it is so marked as to be conspicuous, and is all the more significant because the subjects themselves knew nothing of a distinction between regular and irregular responses.

In the remainder of the chapter, the four classes of participant responses will be analyzed from the point of view of the subjects' reports. The purpose will be to discover the conditions in which the various kinds of behavior occurred and thus to disclose some of the factors involved. Since the irregular forms received more specific comment than the regular, they will be taken up first. Each group will be di-

vided into a number of classes on the basis of the circumstances which seemed responsible for the reaction.

I. *Irregular Reactions*

A Repetitions following Failures. 108 cases.

Class 1. 24 cases. The incorrect hypothesis was repeated because the subject thought he had used the right principle, but had possibly made a mistake in the details of execution.

7.—10.4 sec.—"I don't know why I slipped up on that one. I think it's right to mark the ones on the left, but maybe I made a mistake in the symbol or something. I am going to try the same thing again."

Subject E—Problem A II.

These reactions frequently, though not always, were responses to hypotheses which had given at least one success.

Class 2. 19 cases. The subject repeated his hypothesis "to give it another chance."

11.—8.7 sec.—"I'll try that again. I don't like to leave it without giving it one more trial."

Subject J—Problem B II.

14.—8.3 sec.—"Just trying the same thing again to be sure."

Subject D—Problem C II.

The attitude here is similar to that of the preceding class, but in these reactions the subject did not expressly state that his mistake was possibly a matter of detail. He simply indicated an unwillingness to abandon his reaction without testing it further.

Class 3. 9 cases. The hypothesis was repeated because it had previously given success.

9.—6.4 sec.—"I think this one gets you right oftener that it gets you wrong and if I try it again, it may bring out something."

Subject J—Problem B II.

18.—15.6 sec.—"Anyway, that's been right before. I *know* it's been right before."

Subject B—Problem A III.

It is not always easy to tell just what the subjects meant by this procedure. Sometimes they seemed to be trying "to bring out something," but occasionally, as in the second illustration, they seemed to be clinging doggedly to something that had once been successful.

Class 4. 6 cases. At times, a subject persisted in a line of conduct because he thought it "ought to be right." Evidently reactions of this kind belong to the variety which Ruger calls "volitional."[3]

18.—7.7 sec.—"Wrong? I don't believe it. I think it will work anyway. I'm trying the same thing again."

Subject B—Problem A III.

17.—26.0 sec.—"Well, it seems as if it ought to be right. It seems a good thing to work on, so I'll try it again."

Subject C—Problem A III.

All these responses were connected with hypotheses which had at some time given success.

Class 5. 16 cases. The repetitions in this class were attributed to absent-mindedness.

12.—36.9 sec.—"I didn't realize that I was marking it the wrong way again. I was thinking of something else. I was thinking that in the last one the figures were touching at only one point and here they are touching at two, and I was wondering if that would make any difference. I don't think I paid much attention to the way I marked it."

Subject H—Problem A I.

Apparently, in these reactions thought and overt reaction became temporarily dissociated.

Class 6. 6 cases. These reactions were due to simple impulsiveness.

22.—5.4 sec.—"It was a slip. I didn't realize that I was doing the same thing again."

Subject H—Problem C IV.

17—4.6 sec.—"I did it before I thought. I did it too fast. I didn't realize until I marked it that it was the wrong one again."

Subject B—Problem A IV.

Class 7. 16 cases. In these reactions, the subjects seemed to realize that the situation demanded a change, but were unable at the moment to invent a new hypothesis.

21.—28.8 sec.—"I know it isn't right. I did the same thing again and it's wrong, but I couldn't think of a thing."

Subject A—Problem A VI.

With a situation before them, the subjects seemed impelled to act promptly, though the experiment set no limit on the

[3] Ruger, op. cit. pp. 17, 30.

amount of time to be devoted to any one card. Though they knew that they were gaining nothing, they yielded to the impulse to dispose of the situation somehow—and it is indicative of the strength of the participant tendency that, instead of reacting overtly with no hypothesis at all, they used a hypothesis known to be wrong.

Class 8. 12 cases. The reactions of this group are distinctly different from all those mentioned so far and probably represent a higher level of behavior. Here the subject repeated a hypothesis, disregarding its chances of immediate success or failure, because by doing so he could discover a specific fact. In other words, he took advantage of a particular set of circumstances and employed a hypothesis, used before in known conditions, as a tool for isolating some one bit of knowledge.

8.—12.8 sec.—"I marked it the same way this time because the elongated figure is on the left and the last time it was on the right. I want to see if position has anything to do with it."

Subject B—Problem C II.

12.—56.4 sec.—"At first I thought I'd try working on the angular figure for a change, then decided to confine myself to the curved figure. I compared the present card with the previous one and noticed that in both the curved figures were on the right hand side, on the last card underneath and in the present one above. So I thought I'd mark the curved figure again, to see if I could find any relationship between the curved figure being on the right and beneath."

Subject F—Problem A IV.

Sometimes the reaction is fairly simple, but it may become an elaborate enterprise persisting through several reactions. These reactions are definitely experimental in purpose and presuppose a rather high organization of response.

B. Changes following Successes. 241 cases.

Class 1. 92 cases. At times the reaction was changed after a correct performance because the new situation was different from the one just marked. These reactions sometimes constituted definite progress toward solution. The subject, having just learned that a given marking was right in certain conditions, might deliberately investigate features which were new or different—and possibly significant. In this way he might broaden his knowledge, make it more de-

finite, or establish useful distinctions between situations which were right and those which were wrong, when they were treated in the same way. At other times, however, the reaction was not so deliberate. The mere presence of novelty or difference seemed sufficient in itself to evoke a change of response without any particular consideration on the part of the subject.

5.—15.1 sec.—"Oh! They are going the other way. I mean the lower one is on the left and it has been on the right. I think, when they come this way, I'll mark the upper one. That will show whether I've been getting them right because they were lower or on the right hand side."

Subject J—Problem C I.

4.—15.1 sec.—"Well, that's different. The little one is straight this time. I thought that might make a difference, so I marked the long one."

Subject E—Problem C II.

Class 2. 68 cases. In some cases, a subject changed a successful response because another hypothesis occurred to him. These reactions, too, sometimes represent distinct advances in thinking. Having achieved a success, the subject might think of another hypothesis which would account for the facts, and proceed to try it out.

11.—9.9 sec.—"Let me see. There are two other things that might explain that. First, it may be the figure with the greater number of separate lines in its perimeter. The second is that the correct marking may be the upper one time and the lower the next I tried the first hypothesis this time." (Right)

12.—5.1 sec.—"Now I want to test the other hypothesis and am marking the lower one. According to the first hypothesis, this one will be incorrect." (Wrong)

Subject H—Problem A III.

2.—7.8 sec.—"After you said 'That was right,' I got to thinking that it might have been right because it was next to the red star, so this time I changed from straight lines to the figure next to the red star to try it out."

Subject D—Problem A V.

This class is particularly interesting because it shows how the subject may use successes as suggestions for new hypotheses. The new hypotheses, however, were not always definitely suggested by preceding successes. They were sometimes ideas that "happened to occur" at the time.

Class 3. 8 cases. These reactions form a small but important group of cases in which the hypothesis was improved through generalization and simplification.

44.—5.1 sec.—"I marked the under figure with its own sign. When the curve is under, give it its own mark, and when it is on top, mark the upper with the sign of the under." (Right)
45.—8.3 sec.—"Oh! Always mark the curved figure with the sign of the under." (Right)

Subject A—Problem A IV.

Here, the facts of the case, though retained unchanged, were so completely reorganized that they practically amounted to a new hypothesis. This reaction is probably analagous to the formation of higher units in motor learning, for instance in telegraphy and typewriting. A significant feature of the response is that it goes beyond the demands of the outer situation in the direction of greater efficiency. The old formulation would have given success consistently, but the new one was more economical.

Class 4. 23 cases. These cases are similar to the "experimental" reactions discussed in Class 8, under the general heading of "Repetitions following Failures." They were responses in which the subject, by changing his hypothesis after a success, was able to isolate a particular fact. There is no need for discussing this behavior further at this point, since it is essentially the same as that described before. It is only necessary to point out that these experimental hypotheses may be changes as well as repetitions, and may follow successes as well as failures.

It is well to note at this point that in all four of the classes mentioned so far, successes have figured as possible means of definite advances.

Class 5. 3 cases. The 3 reactions of this group were considered changes, though the subjects themselves thought that they were repeating correct hypotheses. They were really slips into incidental reactions associated with the correct performance.

4.—16.2 sec.—"When the double line figure is on the left, mark it with the sign of the other figure." (Right)
5.—5.6 sec.—"Just the same as last time. When the double line figure is curved, mark it with the sign of the other." (Wrong)

Subject E—Problem A III.

Class 6. 47 cases. This class is composed of reactions in which the subject, though changing from the hypothesis just used, did not adopt a new hypothesis, but returned, instead,

to one he had used before. These returns to old hypotheses may be divided into three sub classes.

(1) First sub-class. 8 cases. In these cases the subject failed to recognize the hypothesis as one he had formerly used, but thought that a new theory had just occurred to him. Except for the fact that they were based on this mistaken impression, the reactions are exactly the same as those included in Class 2.

(2) Second sub-class. 5 cases. This group includes reactions in which the subject was doubtful whether or not he had used the hypothesis before. That is, a hypothesis occurred to him, he could not remember whether it was old or new in this particular problem, and he tried it "to give it a chance."

(3) Third sub-class. 34 cases. On all these occasions the subject recognized the hypothesis as an old one. The reactions of this class were like those of Class 1 in that a "different" situation constituted the stimulus for the change. But here the "different" situation was one which the subject had previously met successfully and in consequence he returned to his former reaction. In fact, these responses were partial solutions of the problem, representing various degrees of insight.

It will be noted that the returns to old hypotheses involve no really new modes of behavior. The first two sub-classes are essentially attempts to try out new hypotheses and the third is made up of responses to changed situations. That is, they are occasioned by exactly the same stimuli that brought about most of the other changes after successes.

II. *Regular Reactions*

A. *Changes following Failures.* 817 cases.

Class 1. 684 cases. In this large group of cases, the subjects evidently considered it unnecessary to account for their conduct in any way. As was said before, when engaged in the regular forms of participant behavior, they usually made no comment on the fact. This does not mean that their reports were always limited in content, but that no reasons for making changes were given.

Class 2. 15 cases. This class includes another group of

"experimental" reactions in which the subject changed to a new hypothesis in order to discover a particular fact. Their occurrence here emphasizes the point that the success or failure of the preceding performance and the change or repetition of the hypothesis itself are in themselves incidental features—that the important point, so far as this response is concerned, is to get a hypothesis which, by taking advantage of certain circumstances, will reveal a fact as yet unknown.

Class 3. 118 cases. In this group, as in changes after successes, there are a number of returns to old hypotheses. The same sub-classes appear.

(1) First sub-class. 27 cases. This group includes cases in which the subject did not realize that he was using an old hypothesis, but acted under the impression that he was making a new response. Naturally no comments were made on situations of this sort; they were evidently cases of simple forgetting.

(2) Second sub-class. 8 cases. These reactions were of the doubtful sort. The subject could not remember whether or not be had used a particular hypothesis before, and tried it out to be sure.

(3) Third sub-class. 83 cases. Here the subjects knew that they were returning to old hypotheses and explained their behavior in the following ways:

(a) There were 30 cases in which the subject recognized a particular situation as identical with one that had occurred before, and remembering how he had marked it and also that it had been correct, proceeded to repeat the performance.

21.—8.3 sec.—"I remember that one. I marked the circle and it was right, so I'll do the same thing again, though I have no idea why it is right."

Subject C—Problem A III.

Essentially, this is a repetition of a correct response, though the repetition is separated by several reactions from the previous use of the hypothesis.

(b) In 21 cases, the subjects remembered how they had marked a similar card and also remembered that the marking was wrong. Nevertheless, they declared that they could think of nothing else to do, and marked it according to the old plan.

20.—18.5 sec.—"I know that's wrong. I've had the same kind before and that's the same way I marked it then and I know it's wrong. I

marked the triangle with the sign of the other one. It's stupid to sacrifice a card that way."

Subject D—Problem A IV.

(c) In a group of 20 cases, the subjects used hypotheses which they knew had been used before, but gave no explanation of the fact.

(d) There were 9 cases which were essentially the kind of reaction described in the third class of repetitions following failures. A subject occasionally returned to an old hypothesis because "it is right sometimes," and in 2 of the 9 cases, the subjects expressed the idea that if they could find out when it was right and when wrong, they might get a clue to the solution.

(e) In this group, too, there were 3 reactions of the "volitional" type. The only respect in which they differed from the ones described above is that the hypothesis which the subject thought "ought to be right" was not the one that immediately preceded the reaction in question.

Again it will be observed that returns to old hypotheses do not involve new modes of behavior.

B. *Repetitions following Success.* 386 cases.

Class 1. 305 cases. In these cases, the subject made no comment on his action, again taking the regular kind of behavior for granted.

Class 2. 37 cases. Sometimes the subject repeated a hypothesis which had just been successful, in spite of the fact that he saw possible reasons for not doing so. He might realize that the new situation differed in some way from the one preceding it, yet persist in the old reaction.

4.—11.6 sec.—"I noticed that the curved figure was below the line this time, whereas formerly it had been above. I realized that the reversal of the position of straight and curved figures might make a difference, but marked it as I did before."

Subject H—Problem D I.

Class 3. 33 cases. In these reactions, the subjects had new theories in mind, but did not try them out.

7.—9.0 sec.—"I thought then of marking just the straight line figure, not thinking of the position of the curved figure or of the star. Then I thought I might as well continue the old marking since that was right."

Subject F—Problem A V.

The cases of Classes 2 and 3 may be compared with those reactions in which changed situations and new theories *did* bring about changes of reaction. An objective difference in the situation occasioned a change in 92 cases, but failed to do so in 37 instances. In 68 cases, new theories were actually tested, but in 33 cases they were not used. That is, in 71 per cent of the cases, the tendency to change in response to an objectively different situation was stronger than the tendency to repeat a successful response; and in 64 per cent, the tendency to try out another hypothesis overcame the tendency to continue a response which had been found satisfactory.

Class 4. 11 cases. Occasionally certain reasons in addition to past success were given for repeating the correct response. In these cases, the hypothesis was supported by observations and considerations which made it more plausible in the eyes of the subject.

8.—17.1 sec.—"I put the insert in the one below. Besides, it has straight lines and I thought that might be another reason for doing it."

Subject G—Problem A III.

8.—6.5 sec.—"I marked that according to the same principle—inner and curved. And it has the central position, too. As I remember, those that I have marked correctly have been in this position."

Subject K—Problem B I.

This behavior practically amounts to bolstering up a hypothesis—fortifying it after it has been accepted. Sometimes it improves the hypothesis by making it more complete; but more often it confuses the situation by dragging in irrelevant considerations which cause trouble later.

The combined evidence from the subjects' reports brings out the following points:

1. The general result is to reveal other factors besides tendencies to avoid failures and repeat successes. Four of these are especially prominent; two of them tending to produce variation of response, the other two tending to keep it unchanged. Those most frequently responsible for change of reaction are (1) discoveries of new or different elements in the objective situation, and (2) the invention of new hypotheses—both of them at times effecting changes in spite of preceding successes and at other times failing to do so. The factors most commonly operative in bringing about repe-

titions are: (1) an inability to produce variations in response, and (2) a conservative tendency covering a wide range of cases. The latter extends from a reasonable unwillingness to give up a hypothesis not thoroughly tested to an irrational "volitional" tendency.

2. The reports also show that participant behavior does not always represent a straightforward advance toward solution. They reveal the presence of many factors which delay and block progress, such as forgetting, impulsiveness, absent-mindedness, inability to invent new reactions, and confusions of essential and incidental features.

3. On the other hand, the reports indicate that participant behavior may be the basis for some of the higher forms of response. One of these is the improvement of objectively adequate hypotheses through more complete generalization. Another is the use of a hypothesis as an instrument of experimentation for isolating a particular fact.

4. Finally, a point which is perhaps worth special emphasis is the fact that, among the irregular responses, those following successes are likely to represent real advances in thinking. The illustrations have shown that, after a success, the subject sometimes thinks of new hypotheses to explain the case; and at other times, having learned that a response is successful in certain cases, he widens his knowledge by responding specifically to features which are new and different and which may be significant. Occasionally, too, on the basis of several successes, an individual makes a generalization which simplifies and unifies his hypothesis. Besides, approximately half of the reactions in which hypotheses were used with definite experimental intent followed successful experiences. These facts form the first indication of a point which appears in several connections in this study; namely, that successes may be as important as failures in stimulating certain thought responses; that at least there are some advances which do not require the immediate stimulus of failure; and that in some conditions, successes may supply the material for positive contributions to progress. Certainly, in the cases cited above, concrete successes served as bases for operations by means of which the individual broadened the scope of his activities or otherwise improved his reaction.

Summary

In view of the current theories on trial and error in thinking, it is not surprising that participant behavior should present the characteristics of a fundamental and deeply rooted response—that it should be widespread in distribution, that it should be relatively free from individual differences, and that it should represent fairly definite and well established modes of procedure. Nor is it surprising that its regular or trial or error tendencies should be stronger than its irregular forms. In fact, the surprising feature of the situation from this point of view is that there are some reactions, those of the spectator group, which fall outside the field of participant behavior altogether. Still, the situation signifies that thinking is very largely the old trial and error response, operating at a new level and somewhat modified in form.

But, however firmly established the response may be, it does not involve rigidly fixed connections. On the contrary, it represents a curious mixture of definiteness of pattern and flexibility of procedure—definiteness, because, on the whole, it shows the same characteristics and the same relative strength of component tendencies, in whatever individuals and problems it appears; flexibility, because it is so responsive to the conditions of the moment that even the strongest of its tendencies may be suspended for the time.

The conditions of this experiment make it possible to analyze participant behavior into a number of distinct but interrelated factors. First of all, there is the general tendency to respond positively to the situation—to do something definite about it. Allied with this are the two regular trial and error tendencies to repeat successes and avoid failures. But all the considerations leading to irregular forms of the response represent factors which complicate the situation as regards change and repetition of reaction. For example, one group of factors, conservative in effect, tends to preserve hypotheses for a time, even though they have been found wrong on particular occasions; while another group, indicating responsiveness to novelty both subjective and objective, extends the sphere of reaction beyond the response which has just been called right. Besides, there are untoward factors, like forgetting, absent-mindedness and impulsiveness,

which may temporarily block progress. On the whole, the situation is extremely complex and apparently any one of a number of factors may attain a temporary dominance.

Finally, it should be noted as one of the characteristics of the process, that among the departures from strict trial and error, the reactions following success are more likely than those following failure to represent genuine advances in thinking.

CHAPTER V

Spectator Behavior

Spectator behavior has not appeared in experiments on thinking heretofore, at least not in the isolated form which marks it as an activity separable from trial and error. This does not mean that the kind of thinking it represents has not been recognized as a possibility. Evidently Bacon had something of the sort in mind in recommending a scientific procedure which consisted in part in collecting facts and letting general laws and tendencies emerge.[1] But actual experimental studies have brought "participant" tendencies to the fore—tendencies to make definite attacks on a problem, to undertake specific tasks, even to make assigned tasks more specific than they are.[2]

The present study, though it occasionally exhibits spectator behavior in isolation, shows that it is an exceptional mode of response. Spectator behavior was not used by all individuals and did not appear in all problems; it was not an indispensable procedure. It was never the first response elicited by a problem; it was never the sole method of dealing with a problem; and there was no problem which was not solved by more than one of the subjects without its use. It was not employed by any of the subjects in all of the problems—not even by those most addicted to its use. On the assumption that the stronger of two tendencies is the one that has the initial advantage and is more frequently and generally aroused, the spectator response is second to participant behavior from every point of view.

Since spectator behavior is the exception rather than the rule, the question naturally arises as to the conditions in which it appears.

Spectator Behavior and Individual Differences

It has been suggested that it may be a matter of individual differences. The fact that some individuals used it more frequently than others was brought out in the preceding chapter,

[1] Bacon, Novum Organum, Book II, Aphorism X.
[2] Messer, op. cit., p. 22.

where participant and spectator behavior were compared in distribution. There the frequency of the response was found to vary from zero, in the case of one individual, to involvement in over half of the total number of reactions, in the case of another. Individual differences become even more apparent if the three forms of spectator behavior are examined separately. Those forms, it will be remembered, were the "primary," in which the subject reported no hypothesis at all; the "secondary," in which he used a hypothesis known to be wrong, either because he could think of nothing else or because "it might bring out something," and the "momentary" in which, for one reason or another, he fell into the spectator attitude for a single reaction. In the following tables, the distribution of spectator responses among these three forms is presented. The first table is based on the number of *separate occasions* on which the response appeared. That is, each "momentary" reaction and each *series* of reactions of the "primary" and "secondary" forms is considered a separate event. In the second table, as a somewhat different measure of the extent to which the method was used, the *total number* of reactions of each class is recorded.

Subjects	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*J*	*K*	*Total*
Primary	1	0	0	7	2	0	0	0	2	11	23
Secondary	1	1	0	0	1	2	0	1	7	8	21
Momentary	3	7	1	2	7	1	0	8	1	2	32
Total	5	8	1	9	10	3	0	9	10	21	76
Primary	7	0	0	29	18	0	0	0	18	131	203
Secondary	6	17	0	0	4	28	0	12	55	41	163
Momentary	3	7	1	2	7	1	0	8	1	2	32
Total	16	24	1	31	29	29	0	20	74	174	398

That is, individuals differ not only in the frequency but in the form in which they use spectator responses. From the stanpoint of frequency, the range is from 0 to 21, when separate occasions are considered, and from 0 to 174, when the total number of reactions is taken as a measure. As to the forms used, the "primary" and "secondary" forms are most common in two subjects each, and the momentary in five. In other words, the distribution of reaction among the three

forms of spectator behavior, is not so regular as among the four classes of the participant response. The whole pattern of conduct seems more subject to individual differences.

Spectator Behavior and Differences in Problems

But to say that the response is influenced by individual differences, is hardly to explain it. The distribution of the reactions among the various problems is more significant in this case. A mere inspection of the data shows that they occurred in problems of two sorts—in long problems and in problems in which no aids were given. In order to bring out the evidence on these points, the following tables were prepared. In the first, the problems were divided into two groups on the basis of length, as involving a larger or smaller number of trials than the median problem of the experiment. In the second, the problems were divided into two classes on the basis of the presence or absence of aids. In both tables, the absolute frequencies and the percentages are given for all three forms of spectator behavior, and, in addition, the differences between the obtained percentages and those which would be expected according to chance are indicated. The comparison of obtained and chance percentages is particularly necessary in the second table because the aided and unaided problems do not form two equal groups and, as a consequence, the chances for spectator responses to fall into one group or the other are not equal. Since the aided group includes 66⅔ per cent of the problems in the experiment and the unaided group 33⅓ per cent, chance would give 66⅔ per cent of the spectator responses to the aided problems and 33⅓ per cent to the unaided group. The long and short problems, however, form equal groups and chance would therefore give each group 50 per cent. The differences between obtained and chance percentages are indicated in all cases as + or — the quantity by which the obtained percentage exceeds or falls short of the expected figure.

The evidence is especially clear that spectator behavior occurred in long problems. This is true of all forms of the response and remains true whether the number of separate appearances or the total number of reactions is taken as the measure.

		Short Problems (to be expected) 50%			*Long Problems (to be expected) 50%*		
		Frequencies	*Percentages*	*Differences*	*Frequencies*	*Percentages*	*Differences*
Primary	Separate Occasions	0	0	−50	23	100	+50
	Total No. of Reactions	0	0	−50	23	100	+50
Secondary	Total No. of Reactions	7	4	−46	20	95	+45
	Separate Occasions	1	5	−45	156	96	+46
Momentary	Separate Occasions	8	25	−25	24	75	+25
	Total No. of Reactions	8	25	−25	24	75	+25

		Aided Problems (to be expected) 66 2/3%			*Unaided Problems (to be expected) 33 1/3%*		
		Frequencies	*Percentages*	*Differences*	*Frequencies*	*Percentages*	*Differences*
Primary	Separate Occasions	5	22	−45	18	78	+45
	Total No. of Reactions	51	25	−42	168	75	+42
Secondary	Separate Occasions	9	43	−24	12	57	+24
	Total No. of Reactions	97	60	−7	66	40	+7
Momentary	Total No of Reactions	8	25	−42	24	75	+42
	Separate Occasions	8	25	−42	24	75	+42

An objection to this statement might be made, however, on the ground that the presence of spectator responses, especially when they occur in series, may be the very reason that certain problems are long—that long problems do not give rise to spectator behavior, but that spectator behavior may make problems long. The answer to this objection is that, with two exceptions, the long problems maintain their position above the median even when the spectator reactions are excluded—i.e. only two problems would change their classification through this treatment and this change would not materially alter the results. Long problems are long apart from the presence of spectator reactions and represent a state of affairs not determined by that behavior.

The evidence also shows that spectator responses tend to occur in unaided problems. Even when the raw percentages are used, the data show that, with one exception, the balance is on the side of the unaided problems. The exception occurs in the "secondary" form, when the total number of reactions is taken as the measure. But when the obtained and expected percentages are compared, even this exception

shows a slight preponderance on the side of the unaided group; and though the tendency for spectator reactions to appear in unaided problems is neither so marked nor so consistent as their tendency to occur in long problems, nevertheless it is clearly present.

As a rule, then, spectator behavior appears in long, unaided problems, presumably when the subject is having difficulty.

Spectator Behavior and Successes and Failures

Another point which may be significant in this connection is whether spectator responses are more likely to follow successes or failures. In this case, the evidence must, of course, be based on the number of separate occasions on which the subject falls into the attitude. Again it is necessary to compare obtained and expected percentages, since successes and failures did not occur in the ratio of 50 to 50, but of 42 to 58. The method of comparison employed here is the same as that used in the preceding table.

	Following Successes (to be expected) 42%			*Following Failures (to be expected) 58%*		
	Frequencies	*Percentages*	*Differences*	*Frequencies*	*Percentages*	*Differences*
Primary	7	30	—12	16	70	+12
Secondary	8	38	— 4	13	62	+ 4
Momentary	3	9	—33	29	91	+33
Total	18			58		
Average		24	—16		76	+16

The fact that 76 per cent of the cases followed failures, together with the fact that this tendency is shown in the separate classes as well as in the totals, justifies the inference that the subjects were more likely to resort to this device when other methods were failing than when they had just been successful. Still, this tendency is not so clearly marked as the tendency to appear in long unaided problems—a fact which probably means that the total situation was more influential in bringing about the response than the success or failure of the reaction immediately preceding it. It should

be mentioned, too, that often when a spectator response followed a success, the success was one which the subject found inexplicable. "But I don't see *why* it is right," subject J reported on one occasion, "The wrongs and rights seem entirely arbitrary."

The Subjects' Reports on Spectator Behavior

But after all, the most direct way to discover the conditions in which spectator behavior occurred is to find out what the subjects themselves said about it.

According to the subjects' reports, there are five principal reasons for undertaking the spectator response, but the reasons given are not always distinct from each other. In fact, the subjects were not nearly so clear in their statements regarding spectator behavior as in their reports on participant reactions. The reasons for this fact are obvious.

1. The first and most frequent reason for spectator behavior was that the subject could think of nothing to do.

24.—8.5 sec.—"I don't know what I meant by that. I couldn't think of anything. My mind was a blank, so I just marked it. I don't think I had anything in mind."

Subject E—Problem A I.

2. The second reason indicates a kind of dissociation. The action was not primarily due to the fact that the subject could think of nothing to do, but that he was thinking of something else.

18.—22.4 sec.—"I was thinking of something else. I don't know why I did that. It was quite a blow to hear that the last one was wrong and I was trying to see why. I couldn't see why it was wrong to mark left into right last time when it was right both times before that. I wasn't paying attention to this one, particularly."

Subject G—Problem C II.

3. In some cases, the subject seemed to be experiencing a mixture of the two attitudes just described. In these cases—and incidentally this is an illustration of the lack of clearness associated with spectator behavior—the subjects reported both that they could think of nothing, and that they were thinking of something not directly connected with the overt reaction.

33.—8.3 sec.—"I couldn't think of anything to do, so I marked it to get rid of it—no particular reason. I was wondering if you had to mark straight ones one time and curved ones next, or something like that."

Subject B—Problem B II.

4. The subjects sometimes expressed the idea that their random marking might "bring out something." This kind of reaction is more deserving of the name "spectator" behavior than are those mentioned so far, since the subject not only refrained from active participation, but tried to observe the course of events.

8.—6.4 sec.—"I think I'll mark them hit or miss for a while and watch and see what happens. I can't think of anything and I may be able to get something this way."

Subject K—Problem A II.

5. The fifth class of reasons shows a developed or more specific form of the fourth. In reactions of this class, the subjects used "partly right" hypotheses with the avowed purpose of finding out why they were sometimes successful; trying to discover differences between situations called wrong and those called right, when all were marked according to the same principle.

29.—8.8 sec.—"Well, I'm going to mark the middle one for a while. That gets you right over half the time and maybe if I keep track of rights and wrongs I can find out what's right about it."

Subject J—Problem B II.

However, the persistence of a "partly right" hypothesis was not always accompanied by attempts at observation. Sometimes it seemed to mean simply that the subject could think of nothing else to do.

22.—6.7 sec.—"Oh, I don't know what to do! I might as well stick to upper, straight lined figures. They are right sometimes."

Subject E—Problem A III.

The various reasons for beginning spectator behavior are summarized in the following table, where they are classified as to the form of the reaction in which they appeared.

On the whole, the evidence suggests that the primary reason for spectator behavior is inability to think of anything definite to do. The largest single class of reasons consists of 33 cases where the subjects specifically explained their conduct in this way. In the 8 cases of class 3, the inability to think of a hypothesis was given as one of the reasons for the

reaction, and in classes 4 and 5, the subjects implied that they were engaged in observation at least partly because they could think of no definite hypothesis. There is no real inconsistency in falling into the spectator attitude because of inability to think of anything to do and then using the situation as an opportunity for observation. The primary stimulus may be the lack of a hypothesis; refraining from active partici-

Reason	*Primary*	*Secondary*	*Momentary*	*Total*
1. "Can't think of anything."	9	3	21	33
2. "Thinking of something else."	3	1	9	13
3. Combination of 1 and 2.	6		2	8
4. "To bring out something."	5	5		10
5. "To find out why it is sometimes right."		12		12
Total	23	21	32	76

pation may clear the way for observation; and that activity in turn may become so prominent as to lead the subjects to regard it as the reason for their conduct.

The reasons given for continuing spectator behavior are also significant. The next table is based on the comments made by the subjects after they were launched upon this line of conduct; that is, after the first reaction of a spectator series had been made. Since the momentary reactions were limited to one overt performance, they naturally cannot be included in the table; furthermore, not all the reactions of the primary and secondary forms are represented, because the subjects did not comment on their conduct in every reaction of a spectator series. Frequently the report was limited to phrases like "The same" or "Nothing else."

It is interesting to note that the reasons given for maintaining the attitude were the same as those given for starting it. They were distributed as follows.

Reasons	*Primary*	*Secondary*	*Total*
1. "Can't think of anything."	65	8	73
2. "Thinking of something else."	4	8	12
3. Combination of 1 and 2.	6	7	13
4. "To bring out something."	22	37	59
5. "To find out why it is sometimes right."		59	59
Total	97	119	216

Here the classes in which observation is stated as a motive become more prominent than they were as reasons for beginning spectator behavior. This fact is in harmony with the suggestion previously made that the lack of a hypothesis may be the primary stimulus to spectator conduct and that observation may occur as a secondary response. If this were true, it would be natural for the subjects to attribute to themselves a more definitely observant attitude after spectator behavior had been started than at the moment of its initiation. It should be noted, however, that inability to think of anything to do remains a prominent motive, especially in reactions of the "primary" form.

On the whole, the evidence indicates that spectator behavior occurs when participant behavior is blocked by the lack of a hypothesis. It occurs in long, unaided, and presumably difficult problems and is somewhat more likely to follow failures than successes. It occurs when the subjects can think of nothing to do; when, absorbed in something else, they are not concerned with a hypothesis at the moment, or when, unable to think of a specific theory to try, they set themselves more or less definitely for observation. Besides, this response, in comparison with participant behavior, is elicited less promptly, less frequently, and less generally, and therefore seems less closely and naturally connected with a problem situation.

These facts may be explained by interpreting the spectator response as what is left of participant behavior when the hypothesis is subtracted. Some kind of incidental observation must be going on, even when the subject, responding in the regular participant manner, centers his attention on the hypothesis upon which he is acting. In the absence of a hypothesis, this activity, formerly incidental, would occupy the center of attention; indeed the spectator attitude may be regarded as an adaptation to conditions in which it would be advantageous to give observational activities a temporary dominance in keeping the field clear of interference.

Responses Involving both Spectator and Participant Behavior

If this is true, there ought to be cases intermediate between participant and spectator behavior where both activities can

be observed going on side by side. This state of affairs actually exists. Sometimes, in a series of reactions, the subjects, while acting on particular hypotheses, use formulations which indicate a groping for some fact which is evidently emerging through the summation of responses not specifically attended to. The following illustrations represent three different degrees of spectator behavior. They show how three different subjects, in the same problem, III A, by a combination of spectator behavior and trial and error adjustments, evolved the idea of marking the figure with the greater number of sides. The illustrations are arranged in order from "more participant" to "more spectator." None of the illustrations gives the whole problem, but only that portion of it which shows how participant and spectator activity together produced the solution. The point to be noticed is that though the subjects commonly state particular hypotheses, they are also occupied with certain features observed incidentally, usually in connection with successful reactions, and felt to be possibly significant.

In the first illustration, for example, it "occurred" to the subject that the correctly marked figures had projecting angles, then that they more nearly approximated a circle; finally that they had a larger number of sides. The performance gives the impression that though the subject was always reacting in the participant manner, the hypotheses he was using were essentially trial and error adjustments to a vague impression, based on facts only dimly sensed, but felt to be the same from reaction to reaction, and constituting the basis of a gradually evolving perception which became more and more definite through successive trials.

4.—45.3 sec.—"I was greatly surprised that that was wrong and just dismissed that card from my mind. Then I marked the upper again for want of something better to do. I didn't have any good reason at all. It occurs to me now that the figures that had the projecting angles have been the ones that have been right." (Wrong)

5.—3.2 sec.—"Your saying 'That was wrong' confirmed me in the new possibility, marking the figure with projecting angles. I've just been wondering how many figures have projecting angles. I've been thinking of the cross and the diamond and the star." (Right)

6.—14.4 sec.—"I didn't know which one to mark, at first, because both had projecting angles. Then I remembered that on the last card, I marked the one with projecting angles made of straight lines, and decided to try that out here, since it was made up of figures differing in respect to lines being curved and straight." (Wrong)

7.—27.6 sec.—"I tried here marking the figure with curved lines and projecting angles. I don't know just what good I thought it would do. I was wondering whether they ought to be marked according to which one more nearly approximates a circle." (Right)

8.—12.7 sec.—"I don't know whether it's right or not, but I thought I'd try out the speculation of last time, the cross being more nearly like the circle than the diamond." (Right)

9.—4.1 sec.—"I marked that on the same principle. Right after marking it, I thought it might be the figure with the greater number of projecting angles, or the greater number of lines. It would amount to the same thing as approximating a circle and would be less ambiguous." (Right)

10.—3.0 sec.—"I marked that on the basis of number of sides. Before you presented that card, it seemed to me that it would be the more likely thing to use. You wouldn't be so likely to think of approximating a circle, and number of sides would be a more definite rule. So I was all set for this one." (Right)

Subject F—Problem III.

The next selection illustrates a more gradual growth of the concept in question and shows how a generalization was evolved from scattered observations. There are several points which ought to be noted specifically. It will be observed that the subject was becoming aware, in the passage quoted, that certain figures, the "five line figure" and the cross, were likely to be right and that the circle was likely to be wrong. Partial generalizations may also be observed, namely that the figures "accompanying the three line figures" and those "accompanying the circle" are usually right—an approach to the recognition, not yet clearly present, that the correct marking is not determined by one figure alone, but that both figures must be taken into consideration. The references to the "five line" figures and to the "three line" figures possibly indicate that the number concept was gradually insinuating itself into the situation before the subject was distinctly aware that it was being used. It will be observed, too, that the passage is made up of a mixture of participant and spectator reactions, that the subject shifts back and forth from the use of a particular hypothesis to the kind of reaction in which she "didn't have any particular reason for making that," but was "wondering" about something else. In this respect it is a particularly good illustration of a borderline case between participant and spectator behavior.

27.—3.4 sec.—"I marked that simply because I remember that figure. I always get it right when I mark the star." (Right)

28.—6.2 sec.—"I don't know why I did that. I couldn't think of anything to do." (Right)

29.—14.5 sec.—"When there is a curved line figure on top, I'm going to mark the curve, and if the curve is on the bottom.....But these are both curved, so that isn't it. I don't know. I just marked it. I couldn't think of anything." (Wrong)

30.—11.5 sec.—"I didn't mark that at all. I've come to the conclusion that you mark only the ones dealing with the five line figure—the star, you know. No, it isn't that, because I had two right in succession and one of them didn't have the star. Wait a minute, I think in both those I had right, the other figure was a three line figure, one a triangle and one a clover. Those are the only correct ones I can remember." (Wrong)

31.—10.2 sec.—"I decided to mark that one because it accompanies the circle and I don't think I've ever had it right when I marked the circle." (Right)

32.—19.1 sec.—"I didn't have any particular reason for marking that. I was wondering why the last one was right. I don't think it could be just because it accompanies the circle." (Right)

33.—4.8 sec.—"I marked that because it accompanies the three line figure. My reasoning was that they have been right before when they accompany the three line figure. I've been contemplating the three line figure all along. I think that has something to do with it." (Right)

34.—3.5 sec.—"I remember that cross. I had it right before so I marked it again." (Right)

35.—3.4 sec.—"I marked that because it accompanies a three line figure. Oh, maybe not. It is the circle and I don't think it has ever been right to mark the circle." (Wrong)

36.—3.7 sec.—"There's the star again. I always mark the five line figure." (Right)

37.—18.5 sec.—"I thought I'd mark the one with the greater number of sides. I think that's the rule." (Right)

Subject B—A III.

The third illustration presents the same features as the second, except that it exhibits an even more gradual evolution of the solution. Again it will be noted that the subject was learning that certain figures were to be marked and others avoided, and that on the basis of these facts, a generalization gradually emerged, appearing in several trial forms, first as the "cornered figures," then as the "more complicated" or "more elaborate" ones, as the ones having *"more* corners," and finally as the ones with "more lines." An interesting feature of the passage is that all the reactions from the twenty-fifth to the fortieth, inclusive, were correct, in spite of the fact that the subject had not as yet formed an adequate hypothesis, was acting on general impression and scraps of evidence, and was herself dissatisfied with the considerations on the basis of which she was acting. Evidently her general impression was functioning as a practical guide to conduct before it became clear as a definite theory.

24.—55.4 sec.—"I didn't think much about this one. I don't know what I had in mind when I marked it. I was trying to think why the last one was right. I think probably that figure (cross) always gets its own symbol wherever it is." (Wrong)

25.—4.0 sec.—"I don't know. I just marked it. I have no theory." (Right)
26.—4.1 sec.—"There's that figure (cross) again. I'll try marking that. (Right)
27.—55.3 sec.—"But that doesn't help much when that figure doesn't appear. It may not be right anyway. I think whenever it has been right, I have used a figure's own symbol in itself. I'm just wondering if it's right to mark that five-pointed one. I think it's been right whenever I've marked the star." (Right)
28.—14.2 sec.—"I was trying to think if there was any way you could classify the cross and star together—as to having corners or something like that. I marked the diamond here because it is cornered and the circle isn't." (Right)
29.—4.2 sec.—"I marked that on the principle that I marked the five-pointed figure before and it was right." (Right)
30.—16.8 sec.—"The last time I saw this (clover) I didn't mark it and it was right. That's why I leave it empty this time." (Right)
31.—2.5 sec.—"Every time I see that figure (cross) I automatically mark it." (Right)
32.—5.6 sec.—"There, in the last one, I didn't mark the circle so I leave this circle empty, too." (Right)
33.—14.9 sec.—"I don't know why I did that—just chance, I guess. I think I did it because it is a more complicated figure." (Right)
34.5.2 sec.—"I don't know. I avoid the circle. It is too easy. I pick out the cornered figures." (Right)
35.—3.2 sec.—"That's the same principle. It is more complicated. It has more corners." (Right)
36.—4.5 sec.—"There are two of those cornered figures (cross and star) together. I just marked this one (cross). I feel that it is bound to be right wherever it is." (Right)
37.—2.5 sec.—"I marked the more complicated figure." (Right)
38.—5.0 sec.—" Same reason. I am marking the one with more corners, the one that is more elaborate. It seems a poor rule, but it seems to work." (Right)
39.—10.8 sec.—"That figure (clover) always bothers me. It is more elaborate, but the diamond has four corners and it has only three, so I marked the diamond." (Right)
40.—2.8 sec.—"This one is made with more lines. That's a more definite rule. Yes, I'm sure that's right. Always mark the ones with more lines." (Right)

Subject C—Problem A III.

These are all rather extended cases of the summation activity, but sometimes a similar experience seems to be compressed within the limits of a single reaction. For instance, in reaction 6 in Problem A III and reaction 5 in Problem A II, both quoted in Chapter II, the idea of marking the figure with the larger number of sides in the one case, and of marking the figure with curved lines in the other seemed to come as the result of an accumulation of impressions from the past.

It is rather interesting to note in this connection that, on the whole, spectator behavior seemed more effective when combined with participant behavior than when it appeared alone;—more effective, that is, in leading to relevant hypothe-

ses. Unfortunately the evidence on this point is not conclusive and the statement is made partly on the basis of general impressions.

The Effectiveness of Spectator Behavior

The most pertinent line of evidence regarding the effectiveness of spectator behavior is that which shows how actual cases of spectator terminated,—whether or not they led to useful hypotheses. There are three ways in which spectator behavior terminated in this experiment. In 48 cases, the subjects reported that new hypotheses had "occurred" to them, and when this happened, they usually returned at once to the participant procedure. In 27 cases, they noticed something new or different about the situation, and this in turn suggested new hypotheses. There was one case in which the outcome of spectator behavior was giving up the problem without solution.

At first sight, this seems to indicate that spectator behavior is likely to be beneficial, since in every instance but one, it apparently met the need of the moment by supplying the material for a hypothesis. The matter is not really so simple, however.

In the first place, the character of the hypotheses suggested must be taken into account. On the whole, they do not give the impression of great novelty. Usually, though not always, they were modifications of old methods of procedure rather than essentially new ways of dealing with the situation. There were two cases however in which spectator behavior was followed immediately by the hypothesis which constituted the solution. The first occurred in Problem A II, where after a number of spectator responses of the "primary" sort, the subject announced, "I think those with the curved lines are the ones to be marked." The second occurred in Problem C I, as the outcome of a series of reactions of the "secondary" form. Here the subject, who had met both successes and failures by marking the lower figure, continued to react on that basis until he discovered that "Upper and lower make no difference. You mark the right hand figure." There are two cases at least, then, in which spectator behavior seemed to lead directly to the solution.

In the second place, it must be recognized that the appearance of a hypothesis at the end of a series of spectator reactions does not necessarily mean that the spectator responses were instrumental in bringing the hypothesis into existence. Spectator behavior may mean merely marking time. It may be a prolongation of the "blank feeling," the state of inability to think of anything to do, which so often initiates the process. In this case, it may be a necessary transition between the subsidence of old, unsuccessful reactions and the appearance of new ones. Its efficacy would then be negative in character, consisting solely in the removal of interferences. However, the indications are that the process has a positive side, at least at times. The frequently expressed hope that the procedure "may bring out something," and the more direct attempts to find out when a given hypothesis is right and when wrong, indicate the adoption of a positively receptive and observant attitude which may possibly give an advantage to slight impressions which would otherwise be unnoticed, and thus facilitate the process of summation.

The problems in which solutions were most frequently produced by summation were Problems A II and A III. These were the problems in which the concepts of straight and curved lines and the relative number of sides of the figures were used for the first time, and in many cases, those concepts seemed to come to the subjects through the accumulation of impressions of the general drift of experience, rather than through the advancing of definite hypotheses. It has been mentioned before that in one instance, the solution to Problem A II followed immediately upon a series of spectator reactions. In other cases, the solutions were advanced as regular "participant" hypotheses, but were accompanied by comments which indicated that they were based on indistinct impressions from the past. The most common occurrence in these problems, however, was that illustrated by the three selections from Problem A III, quoted above, where both participant and spectator behavior were present and where both apparently played a part in bringing about the solution.

The reason that spectator behavior is more effective in this experiment when combined with participant behavior may lie in the nature of the material employed. Presumably the

process of summation would work best when the material is rich in incidental features—that is, when the constant repetition of the essential feature might make itself felt against a background of "varying concomitants." The material of this experiment, however, is distinguished by a poverty of detail and does not supply a background of numerous varying concomitants. This lack is in a measure supplied by participant behavior, which, with its definite hypotheses, adds content to the situation, makes the most of the few differences the objective situation supplies, and usually makes possible a classification of reactions as right and wrong in certain circumstances. At the same time, the lack of detail which characterizes the material makes it difficult to keep up the participant procedure indefinitely, since the objective situation supplies so few particulars which suggest possible lines of action. This condition would also account for the appearance of spectator behavior in this study and its failure to appear in other experiments on thinking, where the materials have been, for the most part, less artificial and abstract, and where the possibilities for definite participant reaction are less likely to be quickly exhausted.

The whole situation is in accord with the suggestion made above that spectator behavior is what is left of participant behavior when the hypothesis is subtracted from the latter; that some kind of incidental observational activity always accompanies the participant process, but is usually overlooked. This would explain the spectator behavior as the temporary dominance of a normally incidental activity, when the main activity is blocked, and would also account for its emergence at the very time it would be most useful. Those cases in which both participant and spectator behavior can be observed simultaneously represent intermediate stages between the complete dominance of one form or the other.

Summary

Perhaps spectator behavior may be characterized best as primarily a cessation of participant activity when no hypothesis is available, and secondarily a state of affairs which may facilitate processes of summation.

In its most clear-cut form, it appears as an activity separable from participant behavior and representing a distinct

general attitude toward a problem. It seems to be a set, more or less definitely adopted as favorable to the registering of responses not specifically attended to. When it occurs in this isolated form, its primary stimulus is a blocking of the participant response. It appears when the subject is having difficulty, particularly of the sort that makes him unable at the moment to think of a hypothesis. This is a situation in which the accumulation of incidental observations might prove useful in providing clues for new bases of action, and spectator behavior may be an adaptation to the condition which is characterized by this very need. It would then function as a preparatory reaction to the process of summation which in turn might supply the raw material for new theories of action.

But spectator behavior does not necessarily occur in isolation. It sometimes occurs in connection with participant behavior and, in the conditions of this experiment, is more effective in producing relevant hypotheses when it does so. In fact, it is suggested that when it appears in isolation it is simply the emergence of an activity, normally incidental, but made prominent at the time by the fact that the main activity is temporarily suspended. Spectator behavior, then, in its proper setting, has the role of a partial activity in thinking. It is only occasionally, and in exceptional circumstances, that it carries on the major part of the enterprise.

But to say that spectator behavior is ordinarily a partial activity is not to assign it an unimportant role. Dewey,[4] in his analysis of a complete act of thought, speaks of the suggestion of possible solutions,—participant behavior, in the terminology of this study,— as the "heart of inference;" and the present experiment, too, shows that the occurrence of one hypothesis after another is an indispensable part of the thought activity. But it also shows that spectator behavior may sometime be the underlying mechanism by which relevant hypotheses are produced; that it may be particularly useful in registering the general drift of experience by facilitating the summation of responses not specifically noticed. Occasionally, therefore, spectator may assume the role of guiding agency in the participant procedure, determining the course it is to follow by providing material for the formation of hypotheses.

[4] Dewey, How We Think, p. 78.

CHAPTER VI

Processes Resulting in Analysis

Analysis is the first topic considered so far which involves a study of the more detailed thought processes. The first significant fact concerning analysis is the plurality of activities which come under this heading. It becomes apparent very quickly that analysis is a result which may be produced in a variety of ways. Regarding each of the processes by which it may be effected, the following information is available.

1. Its frequency; that is, the number of separate overt reactions in connection with which it appeared. This fact gives a quantitative indication of the extent to which it figured in the thinking activity as a whole.

2. The number of subjects who reported it. There are two ways in which this information may be used: (1) to show whether the process was a common or individual response; and (2) to estimate the reliability of the evidence that it occurred at all. From one point of view, the subjects' reports may be regarded as testimony, and the greater the number of observers who reported an event, the greater would be the probability that the event actually occurred.

3. The percentage of cases occurring after successes, after failures, and in first reactions. Information of this sort may be useful in revealing the circumstances particularly favorable to the appearance of the response. The percentages cannot be taken at their face value, however, but must be compared with what would be the chance distribution of the process in question. In this experiment, chance would give 8 per cent of the cases to first reactions; 39 per cent to reactions following successes; and 53 per cent to reactions following failures, since first reactions, successes, and failures occurred in those proportions.[1] Comparisons may best be made, there-

[1] There is apparently a discrepancy between these figures and those given in the preceding chapter, where the ratio of reactions following successes to those following failures was stated as 42—58. This seeming discrepancy is due to the fact that in studying participant and spectator behavior, only those reactions were considered which followed successes or failures. See Chap. IV, note 2, p. 5. First reactions were excluded. In the present chapter, *all* reactions prior to the solution are included.

fore, on the basis of the difference between the chance percentage and the obtained percentage in any given case. For instance, if 20 per cent of the cases of any one process followed successes, the departure from the chance distribution would be indicated by — 19; whereas if 50 per cent followed successes, the superiority to chance would be indicated by + 11.

4. The probable temporal position of the process in a problem. It may be important to know whether an activity is likely to be one of the first or last responses evoked. This fact can be indicated in a general way by establishing a standard mid point of a problem and giving the percentage of cases which appeared before and after that point. Since problems in which no aids were given were on the whole longer than those in which aids were present, the problems were divided into two groups on this basis. In each group, the mid point of the median problem in length was taken as the standard, and the cases were classified as occurring before or after this point. The length of a problem was measured by the number of trials required for solution. In the unaided problems, the mid point was found to be between the eighth and ninth overt reactions; in the aided problems, between the third and fourth overt reactions. This procedure does not give an exact measure, but indicates the trend of the evidence.

5. The distribution of cases among the various problems of the experiment. By means of this information, it is possible to discover whether a given response is likely to occur in problems with or without aids, in long problems or short ones, in problems in which no successes occurred before solution, or in problems in which both successes and failures were present.

In order to present these facts, the following table was prepared. Section I gives, in the first column, the frequencies obtained for each process, and in the second, the number of individuals who reported its occurrence. Section II is divided into three parts: one for cases occurring in first reactions, one for cases following successes, and the other for cases following failures. In each of these parts, the first column gives the percentage of cases falling within that division, and the second gives the difference between this obtained percentage and that which would be given by a chance distribution. Section III shows whether a process occurred early or late in a

problem. The first column includes cases which occurred in problems without aids and gives the percentage of cases which occurred before the standard mid point—i.e., during the first eight overt reactions; the second column deals in a similar way with cases which occurred in aided problems, showing the percentage of cases occurring within the first three reactions. Section IV shows the distribution of cases among the various problems of the experiment. Concerning each problem, the following facts are indicated; (1) the average number of trials required for its solution; (2) whether it was an aided or unaided problem; and (3) whether both successes and failures or only failures occurred before the solution was reached. If only failures occurred, the fact is indicated by the letter F; if both successes and failures occurred, by the letters S F.

There were eight fairly distinct processes resulting in analysis. Seven of these can be submitted to the treatment outlined, but one of them, largely because it is so pervasive and universal, resits this method of study.

The process referred to is an analysis which apparently goes on at the perceptual level. From the very first, the subjects reacted to separate parts of the situation, evidently seeing them as distinct items in the visual presentation. For instance, they kept referring both by name and by gesture to the various figures used, to their size and position, to new features like the asterisk, or to an arrangement of the figures in some novel fashion. But for the most part, they seemed to take this mode of reaction so much as a matter of course that they made no comment on it; only when an observed fact was new did they mention the matter specifically. However, simply because the process is so pervasive, it cannot be studied as can the processes which are less universally distributed. Since it is present everywhere, it is impossible to discover any particular set of circumstances with which it is most likely to be connected.

Perhaps it ought to be pointed out that the process just mentioned represents the stock of material which the subject had on hand when he began the experiment. The artificial world in which he was placed did not deprive him of *all* his old responses. Certain perceptual reactions, like seeing given arrangements of lines as triangles and diamonds—and inci-

	Section I		Section II					Section III	
			In First Reactions		Following Successes		Following Failures		Before Mid Point
	Frequencies	No. of Subjects	%	Diff.	%	Diff.	%	Diff.	Unaided %	Aided %
Process A	68	10	0	— 8	50	+11	50	— 3	11	15
" B	44	10	0	— 8	92	+53	8	—45	50	16
" C	23	10	0	— 8	56	+17	44	— 9	0	0
" D	123	10	13	+ 5	41	+ 2	46	— 7	20	49
" E	60	10	0	— 8	28	—11	72	+19	25	7
" F	154	10	57	+49	23	—16	20	—33	58	76
" G	50	10	0	— 8	46	+ 7	54	+ 1	51	48

Section IV

Unaided Problems

Problems	A I	A II	A III	A IV	A V	A VI
Av. No. of Trials	9.8	16.5	26.9	29.3	5.3	16.1
S F or F	F	S F	S F	S F	S F	F
Process A		6	22	24		3
" B				6		
" C			1	11	2	
" D			9	23	4	4
" E		1	5	11		15
" F	1	1	6	9	5	4
" G			9	12	1	

Section IV (continued)

Aided Problems

Problems	*B I*	*B II*	*B III*	*C I*	*C II*	*C III*	*C IV*	*C V*	*D I*	*D II*	*E I*	*E II*
Av. No. of Trials	*7.0*	*25.7*	*9.5*	*13.1*	*9.9*	*9.3*	*2.9*	*3.1*	*6.9*	*3.1*	*8.4*	*8.1*
S F or F	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*F*	*S F*	*S F*
Process A		7	1		1	1	1	1	1			
" B	9	6	7	4	6				6			
" C		4			1	3			1			
" D	3	17	4	2	1	10	12	13	7	1	9	4
" E		8	1	1	3	2	1		1	1	4	6
" F	10	20	9	10	12	13	12	12	10	11	5	4
" G	1	6	1	1	4	6	1	2	1		2	3

dentally, certain motor habits like those involved in handling a pencil—were at his disposal from the beginning; and because they were well practiced modes of behavior were unnoticed and unreported.

The other processes resulting in analysis were neither so pervasive nor so inconspicuous, and consequently do not present the same obstacles to investigation. They include events of the following kinds.

A. *The Isolation of a Particular Feature*

This is one of the simplest ways in which analysis was effected. It occurred when a particular figure or situation became detached from the total experience which a subject was undergoing and stood out with some distinctness from the whole. For example,

> 30.—4.1 sec.—"I recognize that arrangement. I marked the circle because I got it right before when I marked the circle, but I have no idea why."
>
> Subject K—Problem A II.

> 27.—8.0 sec.—"There's the star again. I think that's important for some reason. I think I have them right when I mark the star."
>
> Subject C—Problem A III.

> 31.—7.8 sec.—"I won't mark the circle. Circles are not being marked. I marked the other figure simply because it's always wrong when you mark the circle."
>
> Subject D—Problem A III.

Evidently this kind of analysis is a rather mechanical affair of "stamping in." The nature of its distribution, as well as what the reports reveal about the process directly, indicate this fact. From the standpoint of its distribution, the three principal characteristics of the process are (1) that it is likely to appear in long problems, (2) that it appears late in the problem, and (3) that it appears in problems without aids. To be exact, over two-thirds of the cases occurred in problems A III and A IV, the longest problems of the experiment; over 85 per cent after the mid point; and over 80 per cent in unaided problems. The late appearance of the process suggests that it is dependent on a background of experience; and its disproportionate frequency in long, unaided problems indicates that it is a slow operation which does not have time to

mature in problems in which more rapid processes have brought about success. In a sense, it is rather like spectator behavior carried on side by side with the regular participant activity. Where the more rapid forms of response have been ineffective, the summation of observations only incidentally attended to, may result in the isolation of some fact.

The process seems to be independent of successes and failures. The subjects' reports show that the isolated feature may be one which has been associated with either success or failure, and Section II of the table shows that the correctness or incorrectness of the preceding performance makes practically no difference in bringing about the response. This latter condition is what would be expected if the remote rather than the immediate past were the basis of the experience. It is not even necessary that the background of experience include both successes and failures, for three cases occurred in Problem A VI, where only failures were possible.

B. *The Perception of a Changed Feature of the Situation*

This class does not include all the changes that occurred, or even all the changes that were noticed, but only those that were effective in bringing out some feature of the situation explicitly. The following illustrations will show what is meant.

6.—27.3 sec.—"Wait a minute. I have to think. I've been marking 'straight into curved,' but the curve is on the right this time. I might have been getting them right because I was doing right into left. I'll have to find out. I'm marking the same way this time to see if position makes any difference."

Subject A—Problem IV.

5.—24.8 sec.—"I was surprised to hear that the last one was wrong and was pretty cautious about this one. I noticed that this card had a curve for the denominator and a straight figure for the numerator and couldn't remember that any of the others were like that. Then I decided to try something new, putting the curved line figure symbol inside the straight line figure."

Subject F—Problem D I.

The significant fact here is not so much that the subject noticed a change, as that the change made him notice a feature not previously attended to. In the first illustration, the subject's attention was directed toward the position and in the second toward the form of the figures, though ob-

jectively, the stimuli for both those responses had been present before.

The most favorable conditions for the occurrence of this response are two. The first is, of course, an objective situation which differs in some one respect from those that have gone before. The second is the existence of a definite mode of response on the part of the subject. When this definite mode of response meets a changed situation, it is likely to require modification in some respect; and the fact that it can not go on in exactly the same way sometimes calls attention to the feature that makes the change necessary.

The definite mode of response was not always one of which the subject was explicity aware, nor was it always a necessary part of the overt reaction. For example, in the first illustration, the subject had been using the formula "straight into curved," which in the three cards just marked, implied "right into left." In the next situation, marking "straight into curved" would mean marking "left into right." That is, the old response could not be carried out in all its implications; but only when they encountered obstructions did those implications come to the surface. Sometimes, indeed, as in the second illustration, the implications of the old response were so obscure that the subject did not become aware of them until after a failure. In such cases, the first "difference" that the subject noticed was that the old response did not work; only after that experience did he become aware of other differences in the situation.

The existence of a definite mode of response usually implies a series of successes by means of which it was established. This state of affairs is indicated by the fact that these responses occurred in problems where successes as well as failures were possible. In fact, 50 per cent of the cases occurred in the problems of Class B, where the procedure required that the subject make five correct performances in succession before the objective situation was changed by the introduction of "conflict" cases. In all the other problems in which this response was present it was possible for the subject to get a series of at least three successes—but usually not more than three—at intervals throughout the problem.

The distribution also shows that the perception of a difference is more likely to follow a success than a failure. This

would be expected if a definite mode of response were one of the conditions of the process, since in this experiment, a definite response would usually be established by successful reactions.

The length of the problem is apparently a matter of no importance, since the responses occurred both in long and short problems. At first sight, it seems that the presence of clues is important, since 86 per cent of the cases occurred in aided problems. But this is probably due to the fact that only one of the unaided problems made a series of successes possible, whereas seven of the aided problems fulfilled these conditions.

There seems to be no definite relation between these responses and any particular temporal position in the problem. In the unaided problems, the responses in question were as likely to appear before as after the mid point. It is true that in the aided problems, most of them appeared after the mid point, but the problems of Group B were largely responsible for this fact; since, by requiring five correct responses before the "conflict" situations were introduced, they postponed the possibility of the response until at least the sixth reaction. And because the responses in these problems made up over half the number of those belonging to the aided group, they greatly increased the number of cases after the mid point.

C. *The Location of a Difficulty*

In the responses of this class,[2] particular situations or kinds of situations were distinguished from the rest of a subject's experience because they were associated with failure. For example,

21.—15.0 sec.—"I don't know what you do when the straight one is underneath. I stayed with the curved figure even though it was above; but it seemed as if I had marked all the possibilities of a straight figure before. The other rule works regularly when the curved figure is underneath, but not at any other time. I can't seem to generalize it to straight figures."

Subject H—Problem A. IV.

25.—25.2 sec.—"It is easy enough when the corner figure here conforms to the requirements of both principles, but when it doesn't, I

[2] Cf. Dewey, How We Think, pp. 73, 74. A comparison of the location of the difficulty as described by Dewey and as it appeared in this experiment is undertaken in Chapter XII.

can't get on to what is happening at all. I have been trying all along to get a plan underlying both principles and making them work in conjunction, but now I am trying to discover which of these two other figures should be marked in case of a conflict in the corner figure."

Subject K—Problem B II.

These responses imply a recognition of a difference, just as those of the preceding class do, but they differ in two respects from those activities. In the first place, the difference was perceived as the result of a different kind of mechanism. Apparently it was the result of a summation of many experiences with situations of this sort, almost all of which had given failures; it was not the result of a single sharp conflict between a given method of response and a situation not adapted to that response. In the second place, the primary fact from the subject's point of view was not that the situation was different, but that it was troublesome. The difficulty seemed to be felt before the difference was noticed, as such; at any rate, before it was clearly defined.

The definite location of a difficulty was not a frequent occurrence in this experiment in spite of the fact that every subject reported it at least once. It occurred both in problems with aids and without them, but always, as would be expected, in problems where both successes and failures were possible. It occurred a little more frequently after successes than after failures, possibly because the immediate juxtaposition of situations which could be dealt with satisfactorily and those which could not, accentuated the contrast between the two; but since the difference between the percentages is relatively slight in this case, no great importance can be attached to this point. Perhaps the most significant fact about the distribution of these responses is that all of them occurred late in the problem. Only after a person had learned to manage a certain kind of situation successfully, did he become distinctly aware of the kind he could not manage.

The location of a difficulty, as it appeared in this experiment, did not come as the result of a deliberate attempt to analyze the situation. It was something that seemed to happen to the subject. *After* he had become aware that certain situations were giving him trouble, he sometimes examined the situation to see how it differed from others.

D. *Cleavage Responses*

This name has been given to a class of responses which consisted in a simple but thorough going classification of the whole situation with which a subject was dealing. Sometimes, instead of the emergence of a single feature from a whole which remained undefined, the total content divided into two or occasionally three parts in the manner illustrated below.

2.—20.6 sec.—"It seems to me that this whole thing sort of separates into two problems. If the little one is also the one with the fewer lines, give it its own mark, but when it has more lines, I don't know. I think you'd give it the sign of the other figure."

Subject J—Problem C V.

5.—101.9 sec.—"I wonder if there are three rules. Sometimes they are connected so that the point of one touches a side of the other and sometimes a point touches a point and sometimes a side touches a side. I marked the top one for point touching point because when the star was on top and the diamond on the bottom, I got it right when I marked the star. I am just testing it out."

Subject G—Problem A III.

3.—14.6 sec.—"I'll bet that when the double figure is curved you do one thing and when it's straight, you do something else. I don't know what. I think it is double figure with its own sign when it is curved. That's the way I'm marking this one."

Subject A—Problem C IV.

Here is seems as if lines of cleavage appeared in the total mass of experience, separating it into two or three parts which, taken together, include all the possibilities of the case. This response demands a higher degree of organization than any of those mentioned so far. It presupposes that the subject's experience has been accumulated in such a way that it can be handled in parts and still be taken as a whole. This does not mean that the subject has consciously organized his experience. The whole process seemed to take place automatically.

Sometimes the subject had in mind a response for each of the part-situations, but at other times he did not. Frequently he had discovered the correct response for one kind of situation and noted the other as the unsolved part of his problem. In these cases the response was not only a classification, but a location of the difficulty.

At first it seems impossible to connect the facts regarding the distribution of cleavage responses with any particular situation. Cases occurred in long and short problems, in

problems with and without aids, in problems in which both successes and failures were possible, and in problems where only failures occurred. Besides, it seems to make practically no difference whether the preceding performance was correct or incorrect.

The most significant fact about the distribution of these responses is that which indicates their position in the problem. They are the first process of analysis studied so far which occurred in the first response to a problem; and it is important to notice that all 16 of the cases in which this happened occurred in problems in which the subjects were provided with at least two sample cards as aids. In the aided problems, these responses were likely to appear anywhere; they occurred before the mid point as frequently as after it. But where no aids were given, 80 per cent of the cases appeared after the mid point and none of them appeared before the fourth reaction. The occurrence of the response seems to be dependent on the presence of a fairly large store of content, but this may be supplied either by an accumulation of experience or by clues.

It is also important to note that the responses sometimes occurred in problems in which there were no successes. Otherwise, it would be natural to think of cleavage as occurring through the accumulation of material about the two opposite poles of success and failure. Probably something of this sort actually happens, but it does not account for all the facts. It would not explain a division into more than two situations, for example, nor the presence of cleavage responses in problems where only failures occurred before solution. The indications are that when a certain amount of material has been accumulated, it may arrange itself about certain observed differences, even if no contrast has been established between successful and unsuccessful experiences.

E. *Defining Responses*

In these responses, the subjects explicitly defined the conditions in which a given hypothesis was used. This procedure sometimes seemed to force an analysis by creating lines of cleavage in a situation which did not automatically divide in the manner just described. The following example shows

how this device may be carried through a number of overt reactions.

11.—34.5 sec.—"Greater number of sides symbol into the other when both are curved." (Wrong)
12.—29.0 sec.—"Greater number of sides symbol into itself when it is straight and the other is curved." (Wrong)
13.—42.5 sec.—"I am now marking greatest number of sides figure with the symbol of the other when the other is curved. My greatest feeling was that I wished I could remember all of those things." (Wrong)
14.—82.5 sec.—"Greater number of sides symbol into the other when both are straight. This ought to clear up whether greater number of sides has anything to do with it." (Wrong)

Subject A—Problem A VI.

This device may isolate a set of circumstances in which a hypothesis does or does not apply, especially if it encounters both successes and failures. It may bring about a case of cleavage, and with it, a location of the difficulty. It is entirely possible, too, that it may accomplish nothing because the conditions which the subject happens to observe and define may be irrelevant to the problem in question.

The distribution of the response, as well as the comments that occurred in connection with its use, indicate that it is used when a subject is having difficulty with a problem. It appeared most frequently in long and presumably hard problems, over two-thirds of the cases occurring in the six longest problems of the experiment. Most of the defining responses appeared after the mid point. They were somewhat more likely to follow failures than successes and in no case did the response appear before at least one failure had been experienced. Logically, there was no reason why an individual should not always define the conditions in which he used a hypothesis, but actually no one did so. The defining response was not one of the activities immediately called out by a problem situation, but occurred only when the subject began to feel himself in difficulties.

This mode of behavior may be akin to the "volitional" reactions mentioned before, and arise from the subject's desire to keep a certain rule in certain conditions, though it has been proved to be wrong sometimes, or even all the time so far. Or it may be due to an inability to think of new hypotheses and a consequent attempt to see if there are any circumstances in which the old ones can be made to apply.

F. *Deliberate Analysis*

To this class belong those reactions in which the subject stopped and examined bit by bit the information at his disposal at the moment. The source of his information was sometimes his past experience and sometimes the objective situation before him.

4.—14.9 sec.—"I thought that the last one might have been right for one of two reasons. First, it was the figure with the curved lines and I used the sign that belonged to the other figure. And second, it had an open face and I put in the sign of the other. But now I think that the second must be wrong because I tried that before and it was wrong. At least I think I tried it. Another thing, these figures both have the same number of lines, so that couldn't come in."

Subject G—Problem A IV.

1.—52.8 sec.—"I didn't look at the incorrect ones at first because I thought that there were so many ways a thing might be wrong that it wouldn't do any good. First I noticed that the two figures in one of the correct ones were both straight lined figures and I threw out the straight and curved line idea. Then I thought of number of sides and counted the sides in the small figures. I noticed the small figures particularly and tried to figure out why one of them was marked and the other wasn't and saw that the one that was marked had the small number of sides. Then it came to me all at once that you used the sign of the small figure and put it in the figure with the small number of sides. Then I looked at the incorrect ones and thought that in the first one the symbol was right but it was in the wrong figure, and in the second one the wrong symbol was used. Only the process wasn't as slow as all that."

Subject B—Problem C V.

9.—38.4 sec.—"I don't understand this. I've had two right, haven't I? I've had them both right and wrong by marking the top one so I don't think position has anything to do with it. I don't see how it could be straight and curved lines either, because this one has two straight figures and I think one of those before had two curves. The only thing I can see to work on is which one precedes the other in the series—I mean their order when we learned them. I marked the triangle because I think that came before this other one."

Subject E—Problem A III.

The phrase "deliberate analysis" is misleading if it suggets the presence of a special process of analysis, different from those described above. Rather, deliberate analysis is a combination of the several processes discussed. Fundamentally, it is like analysis at the perceptual level, differing mainly in the point that whereas that process goes on automatically, here the subject intentionally pauses to make a thorough inventory of the facts. In the course of this enterprise, differences may be perceived, difficulties located, and cleavage responses effected. But it is worth noting that as in the case of immediate perceptual analysis, this kind of activity al-

ways begins with reactions which the subject has on hand—number of sides, straight and curved lines, and size and position of figures, for instance. New facts and relationships may come out later, but the analysis begins with existing concepts. Furthermore, these concepts function in such a way that the subject immediately *sees* the situation as composed of figures having straight or curved lines, a given number of sides, and certain spatial arrangements.

One of the features of deliberate analysis is that it does not occur until the subject has acquired a considerable mass of material to work with. According to the tables, the most prominent characteristic of the distribution is the relatively large number of cases occurring in first reactions. At first this seems to indicate what is apparently a very natural state of affairs—that individuals, when confronted with new situations stopped to examine them as thoroughly as possible before reacting. But when the facts are inspected more closely, they indicate almost exactly the opposite to be true. Of the 88 cases of analysis that occurred in first reactions, all but 9 occurred in problems in which sample cards were given to the subjects and 7 of the 9 exceptions occurred in problems A V and A VI, where conspicuously new features like the red asterisk and red sharp were used. This means that the subjects did *not* stop and deliberately examine the situation *unless* certain conditions were present—unless, along with the new situation, they were given a certain amount of information regarding it, or unless conspicuously new features arrested their attention.

Still, Section III of the table shows that deliberate analysis was likely to occur early in the problem, even in problems without aids. What usually happened was that the subject made two or three exploratory participant reactions and then in the third or fourth reaction paused for a review of the information he had acquired. But apparently, deliberate analysis may occur anywhere during the course of a problem; it is not necessarily associated with any particular temporal position.

Responses of this sort occurred after both successes and failures. The table is somewhat misleading at this point since the large number of cases occurring in first reactions makes the number both of those following successes and failures seem

disproportionately small. But when these two are compared with each other, the cases following successes are seen to have a slight advantage. A success, especially if it occurred after a number of failures, was likely to arrest attention and stimulate observation. But at times failure also seemed to stimulate the subject to assemble his information and submit it to examination. As a matter of fact, analysis was particularly likely to follow a series of reactions which had given *both* successes and failures. A number of concrete experiences, some definitely successful and others as definitely unsuccessful, increased the subject's specific knowledge of the situation. Thus another line of evidence indicates that a condition especially favorable to analysis is the presence of a large amount of material on which to operate.

Deliberate analysis appeared in all the problems of the experiment, more frequently in those with aids than in those without them. This probably means that, through the various clues, the aided problems gave the subjects a larger bulk of material to manage at the same time. The lowest frequencies were found in problems A I and A II—unaided problems which appeared very early in the experiment. Not only were these problems such that they gave the subject no clues to work with, but at the time the subject encountered them, he had not acquired a set of concepts with which to handle his material. These conditions may explain the absence of the response, since the rest of the evidence goes to show that the two things necessary for deliberate analysis are (1) a fairly large supply of content on which to operate and (2) the possession of previously formed concepts in readiness for use.

G. *The Use of a Hypothesis as an Instrument of Analysis*

The reactions belonging to this class have been discussed in the chapter on participant behavior and include those cases in which a subject used a hypothesis, regardless of its chances of success or failure, in order to isolate some particular fact. It is unneccessary to give additional illustrations of the process at this time. Its essential feature is that it takes advantage of a certain set of circumstances to make them yield a definite bit of knowledge.

On the whole, the distribution of the responses approximates

a chance distribution very closely. This is true as regards successes and failures, position in the problem, and division between aided and unaided problems. It probably means that the factors which determine the appearance of the response are not closely related to these particular circumstances. The impression one gathers from the subjects' reports is that its stimulus is the complex situation which constitutes an "opportunity"—that when certain events happened, the subject sometimes saw that, if properly managed, they could be made to bring out a given fact. However, there are two characteristics of the distribution which may be significant: (1) the reaction did not occur in problems where only failures were possible and (2) it did not occur in the first two unaided problems of the experiment. The possibility of forming two classes of responses, the right and the wrong, and a certain amount of familiarity with the situation, gained either through clues or through experience with the procedure, may therefore be conditions of the occurrence of this response.

Summary

The principal fact brought out by this study is that, strictly speaking, there is no process of analysis;—that the term analysis is applicable only to a result, and that the result may be produced by processes which differ widely in nature.

The circumstances in which analysis is effected are various, but there are three conditions which, in some form, seem particularly favorable.

The first is the presence of a large mass of material with which to operate. In this experiment, no process of analysis occurred until one of two things had happened; either the objective situation had given the subject a certain amount of information, or the subject had advanced far enough into the problem to accumulate a store of experience regarding it. Out of the seven different kinds of processes studied, only two occurred in connection with first reactions, and with the exception of two cases of deliberate analysis, they occurred when the material with which the subject was working was augmented either by the addition of conspicuously new features, or by the presentation of sample cards. Analysis would, by definition, imply the presence of a certain amount

of content, but the results show that this condition is more than a logical necessity. Actually, there must be a certain crowding of facts upon each other before divisions occur in the total mass.

The second condition is that some one feature of the situation must somehow be accentuated, though the way in which this result is accomplished seems to be a matter of indifference. It may occur through repetition and consequent summation, by contrast or conformity with an established habit, or by association with success or failure. Sometimes the process consits solely in this accentuation, and the result is the isolation of a single item from the total situation. But sometimes, the temporary dominance of one item is the starting point of a more general activity, as if the momentary centering of the attention on a single feature were the initial step in a series of shifts which brought out one aspect of the situation after another. "Deliberate analysis" is a particularly good illustration of this event, but the cleavage responses and the perception of a difference show it in a measure.

A third condition favorable to analysis is sufficient familiarity with the materials dealt with to insure the possession of a few definite modes of reaction to it. An existing mode of response immediately singles out of the total situation that aspect to which it applies. This is best illustrated in perceptual analysis, where the mere possession of a variety of perceptual reactions automatically breaks the situation into parts. It is notably true, also, of deliberate analysis, since this process was always begun in terms of concepts which the subject had on hand. But it is also true that cleavage and defining responses and the perception of differences and concrete difficulties presuppose established modes of response. Even the automatic stamping in of particular features requires a background of experience.

It should be noted, too, that successes may play an impotant part in bringing about analysis. It has been customary to emphasize the role of difficulty and failure in initiating analysis, but the results of this study show that success may play an equally important part. In the first place, in those processes where established habits are presupposed, success is commonly the instrument by which they are established; in the second place, the occurrence of successful experiences

is one way of increasing the subject's supply of definite information; and in the third place, concrete successes in the course of a problem have an immediately stimulating effect on deliberate analysis. They arrest the subject's attention, stand out as significant, and become a starting point of active investigation.

Since one of the stimuli to the occurrence of analysis is the presence of a large amount of material, it is not surprising that the general function of analysis seems to be to reduce the supply of content by singling out possibly significant features —recurring features, new or different features, features to which the organism has formed the habit of responding, and features associated with success or failure. In a sense, analysis is a consequence of the fact that an organism is capable of receiving and retaining many impressions, but can deal with only a limited number of them at a time. If the process of accumulation went on indefinitely, the mass of content would be so unwieldy as to be useless and most of it would eventually be crowded out. It would be useful, therefore, if certain features were selected and retained as important, when the material began to reach that stage; and the various processes described in this chapter are ways in which this effect is produced.

CHAPTER VII

Processes Resulting in Synthesis

In this chapter are included all the processes discoverable in this experiment which resulted in connecting remote parts of the subject's experience or in bringing together separate portions of the raw material into new working units. The processes themselves were not always clear, since the subjects sometimes reported the results rather than the means by which the results were obtained; but in these cases, the products were recorded as evidence that a synthesis of some sort had occurred.

The method of studying the processes of synthesis was the same as that used for the processes leading to analysis. The tables which give the results of this study are constructed according to the same plan as that used for the tables in the preceding chapter.

Before going into the detailed examination of the processes of synthesis, it is worth while pointing out that synthetic activities have been taken for granted in some of the processes studied so far.

1. A very simple case of synthesis may be found in the tendency to repeat correct performances and to change the reaction after incorrect ones. Here the subject reacted not only to the card placed before him, but to the experience he had gained in reacting to the one immediately past. At the very least, he had brought over one fact from the previous situation which, together with the objective situation before him, determined his reaction.

2. A more far-reaching form of synthesis was shown in some of the irregular forms of participant behavior, where the considerations on the basis of which departures from the rule were made, were gathered from remote parts of the problem. This was most conspicuously the case in those reactions in which a given hypothesis was used to discover a particular fact.

3. All the forms of analysis, insofar as they were dependent on an accumulation of content, implied the presence of synthesis. Some of the more elaborate forms, "deliberate

analysis," for instance, required the simultaneous presence of materials gained at many different times in the experiment.

In addition to these processes which have appeared incidentally, there are ten kinds of activity, not specifically mentioned so far, which bring about synthesis in different ways. These processes will be studied according to the plan suggested.

A. *General Orientation to the Experiment*

Very early in the proceedings, usually during the first problem, the subjects began to speculate as to the general nature of the experiment. Occasionally they asked outright what the general plan was, but usually they devised theories of their own to account for the experiences to which they were being subjected. For example,

2.—17.6 sec.—"It must be memory work, but I don't know where to place the figures....."

and later,

8.—3.4 sec.—".....I begin to think I see through the experiment, that it was a case of simple memory at first and now you are trying to confuse the memory by putting together different figures and I judge that it may get more difficult by putting together figures that are more and more similar."

Subject G—Problem A I.

Sometimes the speculations were very practical in their intent. In these cases, the subjects apparently formed theories of the general nature of the experiment in order that they might adopt a general method of attack. This kind of response is shown in the record of Subject A, who gave the following statement.

7.—13.3 sec.—"This is like the game of twenty questions. You keep narrowing down the range of possibilities until it gets so small that there is only one thing left....."

Subject A—Problem A III.

Later, the same subject added,

14.—10.7 sec.—".....Now it is getting to be like 'The moon has two eyes, a nose, and a mouth.' I mean that the thing to do is to notice the incidental things. I mean the things that seem incidental. Why, it may be just the way I hold my pencil or something like that that decides whether I'm right or wrong."

Subject A—Problem A IV.

	Section I		Section II				Section III	
							Before Mid Point	
	Frequencies	No. of Subjects	In First Reactions		Following Successes		Following Failures		Unaided	Aided
			%	Diff.	%	Diff.	%	Diff.	%	%
Process A	105	10	24	+16	30	— 9	46	— 7	60	62
" B	32	10	0	— 8	18	—11	72	+19	20	17
" C	26	10	31	+23	0	—39	69	+16	51	50
" D	26	10	54	+46	0	—39	46	— 7	60	100
" E	9	4	67	+59	33	— 6	0	—53	0	67
" F	5	4	0	— 8	37	— 2	63	+10	0	0
" G	10	8	40	+32	30	— 9	30	—23	0	78
" H	8	3	0	— 8	100	+61	0	—52	0	0
" I	116	10	22	+14	30	— 9	48	— 5	40	20
" J	52	10	2	— 6	63	+24	35	—18	57	55

Section IV
Unaided Problems

Problems	A I	A II	A III	A IV	A V	A VI
Av. No. of Trials	9.8	16.5	26.9	29.3	5.3	16.1
S F or F	F	S F	S F	S F	S F	F
Process A	13	6	10	13	2	8
" B	1	5	1	7	1	5
" C	2	2	5	1	1	3
" D	2	4	3	3		5
" E						
" F			1	1		
" G			1			
" H				1		
" I	4	15	17	29	8	11
" J	7	5	4	3		2

Section IV (continued)

Aided Problems

Problems	*B I*	*B II*	*B III*	*C I*	*C II*	*C III*	*C IV*	*C V*	*D I*	*D II*	*E I*	*E II*
Av. No. of Trials	*7.0*	*25.7*	*9.5*	*13.1*	*9.9*	*9.3*	*2.9*	*3.1*	*6.9*	*3.1*	*8.4*	*8.1*
S F or F	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*F*	*S F*	*S F*
Process A	4	6	3	11	2	2	3	2	8	6	5	1
" B		4		1	1		2	1	1	1	1	
" C	1	4	1			1			1	2	1	1
" D		2				1			2	3	1	
" E		1	1		1	3		2				1
" F			1		1				1			
" G						1	3	4	1			
" H						2	2	2		1		
" I	3	13	4		2	3	1	1	1	1	2	1
" J	11	4	7	2	3	1			1		2	

At other times, speculations became very general indeed. For instance,

8.—4.1 sec.—".....It seems to me that this experiment takes for granted the presence of a universal law, the existence of an absolute truth, and the possibility of the solution of all problems if search is continued."

Subject H—Problem B I.

In a later problem, the same subject said,

18.—20.6 sec.—".....The rights and wrongs in these cases are arbitrarily chosen and while, in the search for truth, data may perhaps seem arbitrary, I question whether eventually there isn't some underlying reason for facts being as they are. The present situation is more in accord with the easier theological natural science in which phenomena are explained on the principle 'God wills it.' It does not assume any effort on the part of the truth seeker to find reasons for the phenomena."

Subject H—Problem B II.

But for the most part, the responses of this class were neither so elaborate nor so explicit. The subject's general idea of the experiment usually came out incidentally, frequently as a consideration for action, as in the following case.

1.—8.3 sec.—"First I thought the little red mark might mean doing the opposite. Then I thought, 'No, it wouldn't be that' because you never use exactly the same thing twice and that would be too much like the other one with the little red mark. I just marked the upper one."

Subject D—Problem A VI.

The general idea of the experiment is one of those cases in which the subject reported the product of his thinking rather than the process by which he had attained it.[1] Consequently the distribution of these responses shows nothing about the nature of the process, but rather the circumstances in which the product came to the surface. Those circumstances were:

(1) When the subject was becoming adjusted to a new problem. An unusually large percentage of cases occurred in connection with first reactions. When a subject was faced with a new situation in which he had no way of knowing what to do, his idea of the general nature of the experiment was often given as one of the considerations that determined his reaction.

[1] This fact is in agreement with Ribot's finding that the process by which general ideas are acquired often fails to appear in consciousness. Enquête sur les idées générales, Revue philos., XXXII., 1891, p. 384 ff.

(2) When the subject was in difficulty. After he had experienced a series of failures, or successes and failures which seemed contradictory, the subject sometimes became convinced that he was on the wrong track entirely and would try to make a fresh start. At such times, he was likely to consider the general nature of the experiment, as if to get his bearings. His ideas, on these occasions, were likely to be of the practical sort, concerned with general methods of attacking the problem.

(3) When the subject had solved a problem or had experienced a number of successes and thought he had solved it. When he was marking the cards according to the same principle and was not compelled to devise new methods of response, his activity sometimes became reflective and turned toward general notions of the experiment as a whole.

That is, responses of this sort came to the surface when a subject was beginning a new problem, when difficulties forced him to try to take a fresh start in an old one, or when his attention was free to shift to other matters than the immediate demands of the situation. The responses of this class did not occur when the subject was absorbed in the details of working out the problem.

These facts explain the distribution of the responses among first reactions, successes, and failures. The occurrence of the majority of cases before the mid point is due to the fact that so many appeared in first reaction. As a matter of fact, the activities of this class were distributed throughout the entire course of the problem, some of them appearing very late. They occurred in problems of all sorts, perhaps a little more frequently in unaided than in aided problems.

B. *The Formation of a Set in a General Direction*

This class includes those reactions in which the subject's activities took a general direction, though apparently there was no very definite idea of the details involved in the procedure.[2] For example,

[2] Perhaps the similarity of these responses to Ach's "determining tendencies," and the influence of the "task," emphasized by Watt, should be mentioned at this point. Ach, Ueber die Willenstatigkeit und das Denken, p. 187. Watt, Experimentelle Beitrage zu einer Theorie des Denkens. Arch. f.d ges. Psychol. IV, 1905, pp. 298, 418.

8.—6.2 sec.—"I marked the corner figure. I am all for the simple things now. See what it got me into last time when I tried all those complicated things. There is probably some one thing about this that explains the whole thing."

Subject A—Problem B II.

9.—11.3 sec.—"I marked the one farthest from the red figure with the sign of the other, but I am keeping an eye out for some new way of classifying the figures. It seems to me it ought to be about time for something like that."

Subject F—Problem A VI.

27.—4.8 sec.—"I am trying to see if I can get something out of the order. There is something here that is escaping me and it may be that these figures come in a regular order which determines the marking. I marked the triangle this time and am trying to remember that this clover leaf figure accompanies it and that last time it was a circle and a diamond."

Subject K—Problem A II.

These responses indicate the presence of synthesis in two ways. In the first place, they show that a synthesis of some sort has taken place. The suggested line of action is frequently the outcome not of one experience, but of an accumulation of experiences; in fact, it is sometimes based on the subject's idea of the general nature of the experiment. In the second place, they are sometimes the means of binding together a series of reactions, since the intention to follow a definite direction may persist through several trials and give them a certain unity.

The responses of this class appeared in problems of all sorts, but the four problems in which they appeared most frequently were among the five longest problems in the experiment. With the exception of B II, these were all unaided problems, and B II was a problem in which most subjects were not able to take advantage of the clue given. They were more likely to follow failures than successes and appeared more frequently after than before the mid point. These facts probably mean that definite tendencies to follow certain directions were stimulated when the subject found himself in difficulties.

C. *Specific Plans for the Future*

The reactions of this class differ from those just discussed in that the subjects knew definitely what they intended to do. Sometimes, instead of reacting overtly as soon as they had thought of a hypothesis, they stopped and listed as many dif-

ferent ways of dealing with the situation as they could think of, and announced their intention of trying them out successively. According to their own reports, "it is easier to keep track of everything if you do it this way." They seemed to find a certain advantage in dealing with the situations as a group, as compared with taking each one separately.

3.—84.2 sec.—"I filled in the one with the greater number of lines with its own insert. Then I noticed several possibilities and I thought I might as well be systematic and try them out—greater number of lines with its own insert and with the insert of the opposite, smaller number of lines with the insert of the opposite, both filled in with their own inserts and with the inserts reversed if that's necessary. (Wrong)
4.—7.1 sec.—That is the greater number of lines filled in with the insert from the opposite figure. (Wrong)
5.—5.1 sec.—Smaller number of lines with its own insert. (Wrong)
6.—4.1 sec.—Smaller number of lines with the insert of the opposite figure. (Wrong)
7.—9.2 sec.—"Both, each with its own insert." (Right)

Subject G—Problem A VI.

It is rather interesting to note that in no case did a subject carry out a program of this sort exactly as he had planned it. In the illustration given, reaction 5 was not a part of the original plan. Sometimes the whole plan was abandoned after one or two trials; at other times it was modified in detail.

This type of response involves a definite act of synthesis in bringing together a number of possibilities of action into one group; and if the plan it involves is carried out, it holds together the succeeding reactions in a series which may be treated as a unit.

The response occurred in connection with first reactions and after failures—either when a subject was facing a new situation or when his past efforts had been unsatisfactory and he was practically starting anew. According to the tables, they were about as likely to appear before as after the mid point, but aside from those which occurred in first reactions, they were likely to appear late, if they occurred in problems without clues. With the exception of one case in Problem C III, they were absent from problems which gave sample cards and definite aids. Evidently the device is more likely to be adopted when the objective situation does not provide much information.

D. *The Assembling of Possibilities of Action*

This type of response is like the one just discussed in that the subjects assembled a number of possible ways of dealing with the situation, but differs from it in that the group of possibilities did not become a plan of action. Sometimes the subject merely mentioned them without apparently doing anything about them. At other times, he definitely discarded them as a group, usually on the basis that they were incompatible with the general nature of the experiment.

1.—7.7 sec.—"There are lots of possibilities there,—you might want one mark in each, or you might want each one marked with the symbol of the other, or you want the left one or the right one or you might want the left and right to alternate. I marked the left one."

Subject C—Problem A II.

1.—8.2 sec.—"There I thought it might be curved or straight, or curved into straight or the opposite of that, or the red mark might mean the opposite again and I'd have to mark the one with the smaller number of sides. Then I thought, 'What's the use of thinking all this out?' because I didn't think it would be any of those because they had practically been used before and you wouldn't use the same thing again. So I marked the upper one, hoping to get a few right by chance so that I'd have something to work on."

Subject D—Problem A VI.

Sometimes, even after a subject had discarded a number of possibilities as a group, he returned to them later, especially if he was experiencing a dearth of ideas.

The distribution of these responses is similar to that of the preceding class, as would be expected considering the similarity of the activities themselves. They occurred in first reactions and after failures and, for the most part, in problems without clues. On the whole, they tended to appear earlier in the course of the problem. This may mean that a group of possibilities is less likely to be utilized if it occurs early in the problem than if it appears after a number of possibilities have been tried and found unsatisfactory. Or it may be that the assembling of possibilities undertaken later in the problem is a more serious enterprise, and one based on more knowledge, and is therefore more likely to result in hypotheses worth trying.

E. *Organized Search*

On rare occasions, a subject seemed to use his accumulated experience as a means of directing his investigation. For example,

1.—62.9 sec.—"First I thought I'd look for something similar in the correct samples. I noticed that one had two straight lined figures and so I thought that couldn't have anything to do with it. Then I thought I'd look to see which figure determined the symbol and the next thing I said was that the symbol was always the one that belonged to the small figure. That was before I had any idea of where I was going to put it and I thought, 'Where do you put it?' and then I noticed that it was put in the triangle in both cases and that it was the small triangle in one and the large one in the other. But I knew it couldn't be the rule just to put it in the triangle and then I decided it was the figure with smaller number of sides that would get the mark. So that's the way I marked this one."

Subject C—Problem C V.

7.—72.5 sec.—"Right? Oh what did I do? I kept trying to think why it could have been correct. I got started with the idea of the triangle because that was marked on the correct sample and not on the card I had just marked, and while I was trying to think how both could be right, the idea came that the lower one was always marked. Then I thought that all I had to do was to find out which symbol to use. First I thought it was the symbol of the curved figure because that's the way it seemed in the sample and then I suddenly thought it might be the symbol of the incomplete one because that would hold for both the sample and the last one."

Subject A—Problem C IV.

These responses amount to an organized search for a fact as yet unknown.[3] They seem to involve a general idea of the experiment—for example, that one figure determines the symbol and the other the placing of the symbol—and the ability to take a general direction, though detailed knowledge of the procedure is lacking.

There were only nine cases of this response and they were reported by only four subjects. All the cases occurred in problems with aids. Six of them occurred in the first reactions to those problems, and the three which occurred in later trials occurred after successful, rather than unsuccessful, performances. Cards which the subject himself has marked correctly may serve as clues in the same way as do correctly marked sample cards. It may also be significant that all the cases of organized search occurred in problems which came fairly late in the total experiment. The facts seem to indicate that the occurrence of the response is conditioned by several facts: a background of experience, a certain amount of material to work with, some indications of the nature of the successful response, and definite but generalized modes of reaction on the part of the subject. Of course, on the basis

[3] It is understood, of course, that these responses involve analysis as well as synthesis.

of only nine cases, these indications can be regarded merely as suggestions.

F. *Chance Convergence of Responses*

A few cases of synthesis seemed to be brought about by the chance meeting of two responses. In these cases, two ideas which the subject had had in mind as separate facts suddenly came together and produced a new reaction.

For example, Subject B had decided early in Problem C II that the reason one figure was always elongated was "just to confuse us." She had been working with the general idea of using the sign of one figure and placing it in the other figure and had tried several variations of the plan. Then, in the eleventh trial, her report was as follows:

> 11.—11.1 sec.—"I took the one to the right, with the greater number of sides, and marked it with the symbol of the opposite. Those long figures still confuse me. I always have to think a minute before I recognize them. Oh, I have another thought! Why, I know! You mark the smaller figure and mark it with the symbol of the long one. Yes, that's right. The very fact that one is always enlarged makes it seem probable. How stupid not to think of that before."
>
> Subject B—Problem C II.

> 8.—20.1 sec.—"I am marking under into upper, but that can't be it. It's confusing to have the one that's under the other one higher on the page, because the under one might mean—Oh wait a minute! That's it. You always mark the one that is lower on the page and give it the sign of the one that has the other one superimposed upon it."
>
> Subject A—Problem C IV.

There were only five responses of this sort during the entire experiment. They occurred in five different problems and were reported by four different subjects. They followed both successes and failures and all of them appeared later than the mid point of the problem.

G. *Growth by Accretion*

Sometimes the subject found that while he was dwelling on one idea, another idea, or several ideas would unite with it. The first idea seemed to be a center about which the others arranged themselves.

A simple case, involving only two terms is shown in the following illustration.

18.—11.8 sec.—"It seemed to me that it was the rounded one that ought to get the mark. I was pretty sure of that and while I was thinking about that, it dawned upon me that it got the mark of the incomplete one."

Subject C—Problem A III.

A slightly more complex case is the following.

1.—36.7 sec.—"I got to thinking about curves somehow and then I saw that both marked ones were curved. Then I thought the double lines surely ought to come in because they wouldn't be there for nothing. Then I suddenly thought, 'Always use the symbol of the double figure and always put it in the curved figure.'"

Subject A—Problem C III.

There were ten cases of this event and it was reported by eight subjects.[4] All but one appeared in problems with clues, and four of them occurred in the first reactions to those problems. Three of the responses followed correct and three incorrect performances. The one case that occurred in an unaided problem appeared long after the mid point, but in the aided problems, all but two cases appeared before the mid point. It is hard to connect the event with any particular circumstance except the possession of a considerable amount of content to work with.

H. *Generalization of Two Generalizations*

This process has been illustrated under the topic of participant behavior, as one of the reasons for changing a hypothesis after a correct response. It occurred when a subject had solved a problem in two separate parts which had become separated from each other through a "cleavage" response. Sometimes, after this had happened, the subject saw that the two rules could be reduced to one. There were only eight cases of this response which appeared before the solution of a problem—all of them, of course, constituting the solution. More cases appeared after the solution and will be taken up at another time. All the responses followed successes, as would be expected, and occurred in problems which could be divided into two situations by means of a cleavage reaction.

[4] There may be a similarity between this kind of response and the cases Grünbaun discovered in which a common element dawned upon the observer without actual comparison on his part. Grünbaum, Ueber die Abstraktion der Gleichheit. Arch. f.d. ges. Psychol., 1908, XII, p. 430.

For the sake of completeness, two groups of miscellaneous responses have been added to the more clearly marked classes mentioned so far. All the cases of synthesis have implied dependence on past experience and some of them have involved anticipations of the future, but they do not include all the reactions in which references to the past or future were made. The next two classes consist of cases, not specifically included in the other classes, which show that the subjects were concerned with reactions which had previously taken place or which were about to take place.

I. *References to the Past*

It is difficult to illustrate the responses of this class, because they were of so many different kinds. The following samples were chosen because they represent different occasions on which the subjects definitely turned their attention to past events.

17.—10.4 sec.—"Straight into curved, when curved is on the right. But I have a vague disturbing impression that I marked it that way once before and got it right once or twice and then something happened."

Subject J—Problem A IV.

2.—5.2 sec.—"The things that I have done before always occur to me because I think they may be used again in some new way. Here I marked the curved figure with the symbol of the opposite and yet I think it has something to do with position, not only with the fact that the figure is curved."

Subject C—Problem A III.

8.—32.8 sec.—"I want to go back and see the ones I did correctly. I don't remember which ones they were or how they were marked. This does break one of the fundamental natural ways of problem solving; it doesn't permit one to check over previous solutions—I mean to analyze what the former responses have been, correct and incorrect."

Subject H—Problem A IV.

As these responses show, past experience sometimes served as a basis of criticism for the present reaction, sometimes as a source of supplies for possible modes of reaction, and at other times was recognized as containing useful information if only one had access to it. Occasionally deliberate attempts were made to keep track of what had happened and, at times, particular successes or failures just past would be analyzed in an attempt to understand the reasons for their correctness or incorrectness.

References to the past occurred in all problems, but most frequently in long, unaided problems, as would be expected since, in these problems, the subject was evidently in need of information and had only his past experience from which to gain it. A failure seemed more likely to turn the attention toward the past than a success, though a success just achieved sometimes led a subject to try to account for it in the light of his past experience. The subject was also likely to refer to his past experience in connection with his first reaction to a problem, as if he were trying to bring his store of knowledge to bear on the new situation. References to the past were somewhat more likely to appear after the mid point than before it, both in aided and unaided problems. On the whole, the subjects seemed most likely to refer to their past experience when they were facing a new situation or encountering difficulties.

J. *Anticipations of the Future*

The anticipations of the future were neither so numerous nor so various as the references to the past. They differed from each other chiefly in being more or less specific. For example:

1.—8.5 sec.—"All right, I know this game. I marked the inner one because it conforms to both rules, but you are going to give me one by and by where the inner one does not have the larger number of lines and I'll have to find out which one has the preference, the inner one of this set or the greater number of lines of the up and down set."

Subject D—Problem B III.

3.—4.0 sec.—"This is too easy to be natural. I marked it the same way, but pretty soon you are going to give me something that will make me nervous."

Subject J—Problem B II.

5.—5.6 sec.—"I marked the left hand figure because that was right before, but with low confidence. A metal scurrying now, trying to think what to do next in case that one is wrong."

Subject H—Problem A II.

Anticipations of the future occurred more frequently after successes than after failures, possibly because the attention was free to turn to such matters when the subject was not absorbed in the immediate needs of the situation. Though they did not commonly appear in connection with first re-

actions, they did tend to appear early in the problem. A series of successes early in the problem seemed particularly likely to make the subjects suspicious of what was coming. Anticipations of the future were relatively infrequent in problems where sample cards were given because, instead of speculating about what might happen, the subjects were at liberty to consult the evidence actually before them.

Summary

From these results, it appears that the activities of synthesis are most likely to occur when the subject is facing a new situation—either when he is making his first response to a problem, or when he is taking a fresh start. On these occasions he is likely to bring his past experience to bear on the situation rather definitely, to get together as many possibilities of reaction as he can, or to make more or less specific plans for the future. It becomes evident, too, that synthetic activities are largely directed toward the organism's own responses—that whereas analysis tends to give information regarding the situation which brings out the reaction, synthesis tends to organize the subject's own activities. The fact that synthesis occurs more frequently than analysis in first reactions, especially when the new situation is presented without aids, suggests that the organism is more likely to react, in such circumstances, by assembling its own repertoire of responses than by a careful examintion of the objective situation. This general fact is in harmony with the ease and promptness with which participant behavior is elicited, since it indicates a readiness on the part of the organism to throw its own responses into the situation. But of course synthesis does not represent participant behavior in its naive form; it involves more highly organized and sophisticated responses.

The general results of the processes of synthesis are (1) the production of higher units of various orders and (2) the selection of relevant material by means of mental sets. The higher units differ in the degree of unity they achieve. They may be mere collections of separate facts, as in the responses called "plans for the future" and "the assembling of possibilities of action;" or they may consist in generalizations of various orders where the unity is more complete. In the latter

group are the "general ideas of the nature of the experiment," the "sets in definite directions," and the "reduction of two generalizations to a single formulation." Some of these generalizations, notably the sets in definite directions, become the instruments for fulfilling the second function mentioned, the selection of relevant material. Thus synthesis, like analysis, is a way of dealing with a mass of content. Whereas analysis reduces the bulk of the material by singling out items of importance from material already present, synthesis accomplishes a similar effect by compressing many experiences into a single unit and by limiting the amount of material which is permitted to enter the situation by selecting what is relevant, through the agency of mental sets.

However, the nature of the processes by which these results are accomplished is not apparent in most cases. The subjects' reports usually show that a given event occurred, but do not indicate the way in which it was brought about. This condition may possibly be explained in the following way: (1) The process by which higher units are formed may be a kind of summation: in which case, the process itself would not be observed, but the result would appear and be reported. (2) The selection of material in accordance with a given set is a process of controlled association; and since it is generally true of controlled association that there is little to observe but the emergence of the fact in question, it is not surprising that a similar result should be obtained here. Still, there are undoubtedly cases which are not covered by these explanations. In the first place, the accidental convergence of two ideas brings about a rapid reaction which unites the two into a single response in a manner which seems to be neither summation nor controlled association. Secondly, the assembling of a number of possibilities of action seems to consist simply in suspending overt activity until the situation has suggested not one, but many responses. And finally, there is some evidence to show that the formation of general ideas and general tendencies is not always, or not wholly, a matter of summation. For example, an idea of the general nature of the experiment sometimes undergoes trial and error adjustments resembling participant behavior in that particular events suggest theories which are proved or disproved by subsequent experiences.

Again, as was the case with analysis, the outstanding result of this study is the variety of processes by means of which synthesis is achieved and the diversity of circumstances in which those processes may be stimulated.

CHAPTER VIII

Processes which Result in the Diminishing of Content

The material with which an individual is thinking is not only being broken into parts and combined into higher units; some of it is being discarded as irrelevant or useless, or merely dropped out and lost.

This aspect of thinking has been implied in a great deal of the foregoing discussion. It has been more than implied in Chapter IV, where the tendency to abandon wrong hypotheses was made one of the special objects of study. It will be remembered in this connection that so long as the subject was following the tendency to repeat correct hypotheses and avoid incorrect ones, he said nothing about his behavior; that he seemed to take this procedure for granted, and that only when he departed from it did he consider it necessary to explain his conduct. This means that a certain amount of the loss of irrelevant material goes on without being noticed and reported. That incorrect hypotheses are not ordinarily re-used is a fact which an observer may notice, but which apparently receives no attention from the subject. In this sense, a considerable part of the process may go on underground where it is not open to direct observation.

This does not mean, however, that there is no evidence that the process occurs. In addition to the case just mentioned, there have been other indications that material is being lost or discarded. Some of it is undoubtedly lost through mere forgetting. Many of the references to the past discussed in the preceding chapter were attempts to recall forgotton events —simple statements that they had been forgotten or regrets that opportunities to observe facts and fix them in mind had been overlooked. Then, too, the repetitions of discarded hypotheses, when they occurred without the realization that they had been used before, are a rather paradoxical proof of the occurrence of forgetting. Of course, when things are completely forgotten, no direct statement of the fact is to be found in the records. In the conditions of this experiment, the evidence for forgetting would naturally be fragmentary and circumstantial.

There have also been indications from time to time that the subject was experiencing a dearth of material to work with. Sometimes there were direct statements to this effect, as when a subject declared that his "mind was a blank" or that he "had that blank feeling again," and there is evidence to show that the spectator attitude was frequently, if not always, induced by inability to think of anything to do. These "blanks" are also indirect evidence that used up material was being discarded.

Then, too, in connection with the topic of synthesis, there were cases in which a group of possibilities was brought together and overtly dismissed. This is more direct evidence of a discarding activity, since the event does not have to be inferred. But in all the cases mentioned, the examination of other activities involved in thinking has incidentally brought out the fact that discarding processes are at work.

The cases in which the elimination of unsatisfactory material is expressly mentioned are evidently cases in which the process, which for the most part goes on automatically, rises to the surface and claims attention. There are three clearly defined reactions in which this event occurred and one which is somewhat ambiguous. These responses may be submitted to the same kind of examination employed in the processes leading to analysis and synthesis.

A. *Definite Discarding of a Particular Response*

The first is the simple, overt, definite dismissal of material which has been found not to work. Responses of this kind were not necessarily elimination in the logical sense; in fact, they were rarely that. They usually consisted in abandoning ideas or lines of action apparently because they have been associated with failure, though, logically, some modification of the same material might possibly have brought success. On the other hand, there were some occasions when a particular event, either a success or a failure, convinced a subject that a given method must be wrong—some experience which, in a manner approximating logical elimination, made it apparent that a given response could have nothing to do with the case. The following examples illustrate both these varieties of response:

	Section I		Section II					Section III	
			In First Reactions		Following Successes		Following Failures		Before Mid Point
	Frequencies	No. of Subjects	%	Diff.	%	Diff.	%	Diff.	Unaided %	Aided %
Process A	73	10	17	+9	12	—27	71	+18	50	59
" B	17	7	0	—8	0	—39	100	+47	40	0
" C	64	10	2	—6	0	—39	98	+45	26	9
" D	42	9	10	+2	29	—10	61	+ 8	40	27

Section IV
Unaided Problems

Problems	A I	A II	A III	A IV	A V	A VI
Av. No. of Trials	9.8	16.5	26.9	29.3	5.3	16.1
SF or F	F	SF	SF	SF	SF	F
Process A	5	4	9	19	4	10
" B	1	3	3	4		4
" C	23	1	3	9	4	13
" D	3	2	5	3	3	4

Section IV (continued)
Aided Problems

Problems	B I	B II	B III	C I	C II	C III	C IV	C V	D I	D II	E I	E II
Av. No. of Trials	7.0	25.7	9.5	13.1	9.9	9.3	2.9	3.1	6.9	3.1	8.4	8.1
SF or F	SF	SF	SF	SF	SF	SF	SF	SF	SF	F	SF	SF
Process A		4	2		3	1	1	3	1	1	1	5
" B								1				1
" C		1		1	1					1		7
" D	2	6		4	2	3	2			2	1	

6.—69.1 sec.—"I thought the last one would probably be right and was a little surprised that it wasn't. Then I thought I'd stop working with the greater number of angles idea because I didn't think it was getting me anywhere. Then I thought I'd try interchanging the symbols but I didn't think that would be very fruitful and fooled around a little while but I didn't seem to think of anything better so I marked it that way."

Subject F—Problem A VI.

9.—14.8 sec.—"Well, if that was right, it has nothing to do with position because two times back, I think it was, I got it right by marking the curve when it was on the left and I think the arrangement was the same otherwise. This time I marked straight into the curve, noting that the curve has the larger number of sides."

Subject K—Problem A III.

This mode of reaction seems to be the definite recognition of the same sort of thing that usually goes on without attention or comment. It looks like an attempt to give definiteness and finality to the dismissal of an idea which had been tried and found wanting.

Responses of this class usually followed failures, as would be expected. It should be noted, however, that a success, as in the case of the second illustration, sometimes enabled a subject to rule out a given fact as irrelevant. It is also to be noted that reactions of this class sometimes occurred in first trials. This would seem natural enough if they always occurred in the first trials of problems with aids, where an examination of the sample cards or other clues might show that a method which at first seemed possible did not fit the facts presented. But four of the twelve cases occurred in the first reactions to problems without clues and in these cases, as well as in three of those which occurred in problems with clues, the hypotheses were discarded, not because there was anything in the objective evidence to contradict them, but because the subject "didn't think it would be that." Possibly the reason for rejecting responses in these cases was incompatibility with the general nature of the experiment. The dismissal reactions occurred more frequently in unaided than in aided problems—to be exact, 70 per cent of them occurred in the six problems which gave the subjects no aids. They occurred with the greatest frequency in Problems A III, A IV, and A VI, three of the longest and most difficult problems of the experiment. These facts, together with the fact that they usually followed failures, may mean that when a subject was in difficulty and felt that he was thrown upon his own

resources, he tried to be explicity aware of what he was doing. The dismissal reactions occurred before and after the mid point of unaided problems with approximately equal frequency. In the aided problems, they were a little more likely to come early in the problem, possibly because the presence of more evidence enabled the subjects to discard certain responses with a greater degree of certainty.

B. *The Attempt to Discard All Methods Previously Used*

This class of responses differs from the one just discussed in degree rather than in kind. It seems to be a more drastic experience of the same quality. It occurred when the subject felt that he was on the wrong track entirely and must discard everything that he had been doing. Sometimes this conviction appeared to come suddenly, sometimes as the outcome of an accumulation of experiences. Some illustrations are:

8.— 43.2 sec.—"As soon as you said that that one was wrong, I saw in a flash that none of my hypotheses could be right and that the successes I had were due to accident. The next thing I thought of was number of sides because of all the rules, that made the biggest impression on me ....."

Subject C—Problem A III.

26.—68.5 sec.—"Well, I am now flabbergasted. All of my theories have come to naught. I stand where I did at the beginning, but worse than that because I have little hope left. However, I'll begin all over again. I've been hoping that it had nothing to do with the order they came in originally. I thought of that some time back but put it from my mind. But I'll bet it is. I might as well mark the circle. I think that was earlier in the series than this figure but I'm not sure."

Subject D—Problem A IV.

This type of response occurred more rarely than the less severe cases discussed before and was reported by only seven of the ten subjects. In this experiment it always followed failures and, in 15 of the 17 cases, it occurred in unaided problems. It seemed a little more likely to occur after than before the mid-point.

C. *The Occurrence of "Blanks"*

In this group of responses, though the subject did not explicitly state that he had discarded anything, he reported

what might be the result of a process of discarding especially if it had been going on for some time. For example:

17.—5.5 sec.—"Just desperation. Inability to think of a single thing. I marked it the same way but I know it's wrong."

Subject D—Problem C II.

14.—21.5 sec.—"I ought to have known it wasn't position because of the two I got right. I simply don't know what it is. I can't see any clue to this at all. I'm getting that feeling of vagueness again as if there weren't anything in my mind at all."

Subject E—Problem A III.

21.—6.2 sec.—"I had no reason for doing that except that I had no thought at all. I felt simply blank. It doesn't look as if I'll ever find it."

Subject B—Problem A I.

These blanks were reported by all the subjects, by some much more frequently than by others. They all followed failures with the exception of one case which occurred in connection with the first response to Problem C V where an examination of the sample cards disproved a hypothesis which the subject had evolved and where the removal of this hypothesis was followed by a temporary "blank feeling." Aside from this case, all the responses in the aided problems came after the mid-point, as did 74 per cent of those which occurred in the unaided group. On the whole, they appeared more frequently in unaided than in aided problems and were especially numerous in Problems A I and A VI. These were problems in which no chance successes were possible, but in which failure after failure occurred with nothing to suggest new methods of attack. This condition is particularly marked in Problem A I, possibly because at the beginning of the experiment the subject had not as yet acquired a stock of ideas upon which he might draw in circumstances of this sort. It is also noticeable that Problem E II is the only aided problem which shows a relatively large number of blanks, and since the aid in this problem consisted in the elimination of false hypotheses, it constitutes another indication that the discarding of material may result in the creation of a mental vacuum.

D. *Loss of Material Through Confusion*

This kind of response does not properly belong to the class of discarding reactions, but is interesting in connection with the "blank feelings" just discussed. Sometimes the subject

reported that he could think of nothing to do because he felt "confused" rather than "blank." For example:

43.—8.2 sec.—"I was so confused I couldn't think of anything. The fact that there are three figures and that you can use one or two or three signs and change them around according to all sorts of rules gives you almost infinite possibilities. I was so bewildered I couldn't think of anything definite for a while. Then I tried marking the corner one with the signs of both the others, but maybe I've tried that before."

Subject B—Problem B II.

17.—14.8 sec.—"I was so confused by the great number of possibilities of that idea that I couldn't get anything for a while. Then I put the symbols of both figures in the figure with the greatest number of lines which is also the top figure and in this case curved."

Subject F—Problem A VI.

22.—20.2 sec.—"I felt that there were about a million things to do but nothing seemed to come for a while. Then I put the sign of the larger number of sides in itself which is foolish because those I've had right had the signs interchanged."

Subject D—Problem A III.

15.—65.4 sec.—"A feeling of bewilderment, a little different from the other series. It means that I don't get the hang of the thing, as I did in the others, even if I didn't get the solution. There ought to be plenty of things to work on here; it ought to have something to do with curves and greater number of sides and there is this L shaped arrangement which ought to mean something, but there is nothing clear about it. That's vague, I know. I don't know just how to say it. This is going back, rather foolishly, to the curve accompanied by two straight line figures."

Subject H—Problem B II.

In all these cases, the inability to think of anything to do seemed to be due not to an absence of material, but to the fact that no one feature of a mass of content became dominant at the moment.

The blanks due to confusion follow a somewhat different distribution from those due to the exhaustion of content. For one thing, they did not occur so frequently. Besides, they seemed almost as likely to occur in aided as in unaided problems and they followed successes as well as failures, though not so frequently. A few of them appeared in first reactions, but only in the first reactions to problems with clues. The cases that followed correct performances were usually induced by the addition of some information which the subject could not reconcile with the facts he had on hand. For the most part they appeared rather late in the course of the problem.

Summary

On the whole, it seems fairly clear that the processes of discarding go on continually, but usually without attracting the attention of the subject. Indirect evidences of their occurrence are to be found in such facts as the tendency to abandon incorrect hypotheses, the failure to recognize previously used hypotheses, and other forms of forgetting.

When the discarding activities become overt, they do so when it would be of advantage to the subject to know definitely what he is about—in problems in which he is forced to depend upon his own resources, when his hypotheses are proving to be wrong, and when he has advanced rather far into a problem without consistently achieving success.

The function of these activities seems to be to get rid of useless material and to clear the way for new modes of reaction. But they sometimes result in moments of blankness in which the subject temporarily finds it impossible to do anything at all. The process occurs in various degrees, from the simple setting aside of a wrong mode of reaction to the discarding of everything that has been tried so far.

On the whole, it seems more like a biological avoiding reaction than a process of logical elimination. It seems to be directed toward modes of behavior which have been associated with failure, rather than those which have been proved, by systematic examination, to be logically impossible.

CHAPTER IX

The Appearance of New Responses

The question of how variations arise in a subject's responses has been taken up by a number of writers. Swift[1] and Book[2] find that their coming is usually unobserved; that they may escape attention after they have appeared; and that, on the whole, they are more effective when they do. Ruger's[3] results confirm theirs as regards the coming of variations, but differ as to the desirability of their remaining unnoticed. He finds, in fact, that the effectiveness of new responses varies directly with the degree of attention and analysis they receive.

In the present study even the emergence of new responses was often definitely noticed. Sometimes, indeed, the subjects gave the impression of anticipating their coming and observing them as they took place. Expressions such as "Wait a minute!" "I think I see something," or "Oh! I think I'm on the track of something new," occasionally prefaced discoveries. In fact, the appearance of a new way of perceiving or otherwise reacting to a situation was, from the subject's point of view, one of the outstanding features of his experience. But negative cases undoubtedly exist. In many instances, the experimenter could detect new modes of reaction of which the subject himself was apparently unaware.

In this study, new responses were not primarily variations in motor performance, but reactions involving perceptions and "implicit" manipulation. They include cases in which, for the first time, the subject thought of straight and curved lines, number of sides, and other features of the situation on which to base his reaction. They also include first appearances of manipulative devices—cleavage responses, defining reactions, and deliberate analysis, for example. Of course, in one sense, every slight change in hypothesis is a variation, but, in this study, the term is applied only to hitherto unused ways of perceiving or manipulating the material.

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[1] Swift, "Mind in the Making," p. 213.
[2] Book, "The Psychology of Skill," p. 171.
[3] Ruger, "The Psychology of Efficiency," p. 15.

	Section I		Section II				Section III	
	Frequencies	No. of Subjects	In First Reactions %	In First Reactions Diff.	Following Successes %	Following Successes Diff.	Following Failures %	Following Failures Diff.	Before Mid Point Unaided %	Before Mid Point Aided %
Process A	183	10	61	+59	17	—22	16	—37	48	72
" B	48	10	0	— 8	31	— 8	69	+16	19	11
" C	60	10	0	— 8	17	—22	83	+30	30	38
" D	3	3	0	— 8	100	+61	0	—53	0	0
" E	11	7	0	— 8	27	—12	73	+20	0	0
" F	127	10	68	+60	19	—20	13	—40	44	62
" G	55	10	5	— 3	22	—17	73	+20	21	33
" H			No quantitative results obtained							

Section IV
Unaided Problems

Problems	A I	A II	A III	A IV	A V	A VI
Av. No. of Trials	9.8	16.5	26.9	29.3	5.3	16.1
S F or F	F	S F	S F	S F	S F	F
Process A	18	2	8	7	14	1
" B		11	13	4	8	
" C	21	5	6	7	1	14
" D				2		
" E	1	3	3	3		
" F	2	4	7	9	6	
" G	18	4	11		6	7
" H	No quantitative results obtained.					

Section IV (continued)

Aided Problems

Problems	*B I*	*B II*	*B III*	*C I*	*C II*	*C III*	*C IV*	*C V*	*D I* .	*D II*	*E I*	*E II*
Av. No. of Trials	*7.0*	*25.7*	*9.5*	*13.1*	*9.9*	*9.3*	*2.9*	*3.1*	*6.9*	*3.1*	*8.4*	*8.1*
S F or F	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*S F*	*F*	*S F*	*S F*
Process A	19	5	2	26	16	10			21	21	8	5
" B	4			1	2				3		2	
" C		2		1	2							
" D						1						
" E					1							
" F	18	8		11	10	10			22	18	1	1
" G	1		1	2	4		1					
" H	No quantitative results obtained											

Since the appearance of new responses was frequently observed and sometimes even anticipated, it is possible to make a systematic study of the conditions in which they occurred. They may be classified according to the same scheme used for the processes studied in the last three chapters and the results presented in similar tables on preceding pages.

A. *Observation*

Frequently new responses come into the situation as mere matters of observation. The works "I saw" or "I noticed" usually introduced these reactions, which were likely to be discoveries of objectively novel elements in the situation—the red star, or some new spatial arrangement, for example:

1.—7.2 sec.—"Well, the first thing I noticed was that side-by-side position and I thought I'd try marking both."

Subject J—Problem A II.

2.—11.6 sec.—"I noticed that the little pink star was there again. I saw it the first time but gave it no attention, thinking it was a fluke. Now I think it must be intentional and am marking the figure next to the star."

Subject H—Problem A V.

16.—17.5 sec.—"There I noticed the way they were attached and wondered if that had anything to do with it. Here, in this circle, every point of the star touches the circle, but if the triangle were outside or some other figure, that couldn't happen. I put in as many marks of each figure as there are points touching. I suppose it isn't that, though."

Subject E—Problem A I.

Usually these observations were reported casually, as mere matters of course. Some of them seem to be perceptual reactions which are in an almost permanent state of readiness to be aroused by their appropriate stimuli. In fact, they are probably cases of the response referred to in Chapter VI as "analysis at the perceptual level." In that connection, it was pointed out that unless the observed features were new, the subjects took no special notice of them—that the novelty of the object, rather than the process itself, was the center of the subjects' attention.

Most of these responses occurred in first reactions and an unusually large percentage of them appeared before the midpoint. Still, the fact which perhaps is deserving of emphasis is that the objective features of a situation were not all noticed

at the time of its first exposure, but came out one by one, as the subject advanced farther and farther into the problem. This was particularly true of the situations which were presented without clues. Sometimes even a decidedly novel feature was not specifically attended to at once; for example, in the second illustration above, reappearance of the red star seemed necessary to reinforce and give significance to its presence. At other times, a series of failures seemed to stimulate observation, so that hitherto unnoticed features were revealed. But, on the other hand, a success often roused a subject to activity and initiated a deliberate attempt to note all the features a situation presented.

On the whole, the distribution of these responses among the various problems is not especially significant, and depends largely on whether or not the problem itself presented objective features which were conspicuously new. It is rather interesting, however, that there were two problems, C IV and C V, in which no subject took specific notice of the objectively new arrangements, though a knowledge of these arrangements was implied in the reactions they reported; and in problem A VI, where the novelty consisted in the addition of a rather conspicuous feature, the red sharp, only one subject openly referred to its presence. The last named case is probably to be explained by the fact that in preceding problem, A V, a similar feature, the red star, had not figured specifically in the solution.

On the whole, the process of observation seems to involve a series of perceptual responses in various degrees of readiness for use. Some of them occur so automatically that they receive no attention, while others require reinforcement, through one agency or another, before they are effectively aroused. This fact accounts for the successive character of the process as a whole, which is one of its principal features.

B. *Summation*

One of the most important ways of bringing new material into the situation was by means of a process which appeared to be summation. The concepts of straight and curved lines and of number of sides frequently occurred in this way. These events were reported not as if the subjects "saw them" in the

situation, but as if they "thought of them" as impressions from the past.

13.—17.9 sec.—"I've been wondering if the ones I've had right haven't always had more lines in the figure I marked. I think they have but I'm not sure. I am marking this one because it has more lines than the diamond."

Subject J—Problem A III.

7.—20.7 sec.—"Wait a minute. I think I am getting something. I am going to mark the curve because it seems to me that those I've had right have been curved. I'm not sure, though."

Subject D—Problem A II.

11.—37.2 sec.—"Well, it upset my theory to see that both of these are curved. I rather think though, that the right ones have had more sides and maybe it's been accidental that I've been getting them right when they were upper straight. I'll try that and see."

Subject A—Problem A III.

The lack of confidence with which these reactions were made is characteristic. Evidently the responses were not regarded by the subjects as pure guesses, yet the evidence on which they were based was felt to be slight. They were apparently founded on memories of a sort, but on memories which were vague and insecure.

Obviously events of this sort could not occur in first reactions. As a matter of fact, most of them appeared after the mid-point. They were a little more likely to follow failures than successes, but their essential condition was a past including both failures and successes. When a hypothesis had given several successes and was then found wrong, some feature of the correctly marked situations, hitherto unnoticed, emerged from the background;—as if the definite removal of one possibility of action permitted a response, incidentally exercised along with it, to come to the fore. When the response occurred after a success, it practically amounted to a "perception of a difference," as the third illustration shows. However, this is the same kind of reaction as that just described, except that the theory on which the subject had been working was made impossible by a change in the objective situation rather than by an actual failure. On the whole, the response seemed to involve a combination of stamping in and stamping out,—the stamping out being accomplished by a single sharp experience and the stamping in by a rather weak, because incidental, exercise. Approximately three-fourths of

the cases occurred in problems without clues, where the subject's past experience was his only source of information. It was particularly frequent in problems A II and A III where the concepts of straight and curved lines, and large and small number of sides, were brought into the situation for the first time. The distinctive features of the process are (1) its dependence on both failures and successes and (2) the accumulation of incidental and unnoticed impressions.

The process, in spite of the feeling of vagueness which accompanied it, seemed a distinct kind of experience. The subjects seemed to know that something was happening, before they were at all clearly aware of its nature. The words "Wait a minute" or "I think I see something" indicated uncertainty and hesitancy, and at the same time, the presence of some event to which the attention was being definitely directed. The process was reported by all subjects.

C. *The Removal of Incorrect Hypotheses*

Sometimes the mere removal of old responses seemed the immediate cause of the appearance of new ones. After a series of reactions in which a subject reported "blanks," new responses sometimes appeared as if the clearing away of interferences left the field open for the introduction of new material.

31.—127.6 sec.—"I sat there for a long time trying to think of some way I hadn't used of putting the two signs in the figure and I couldn't think of anything I hadn't tried. Then while I was looking out of the window, I thought maybe you didn't have to use both signs. So I took the sign of the outer figure and put it in the inner."

Subject C—Problem A I.

28.—49.4 sec.—"When you said that was wrong, I had that blank feeling again and couldn't think of anything for a while. Then the idea came that we might have to place the marks outside the figures altogether, so I put both symbols out here beside the figures they belong to."

Subject E—Problem A VI.

The incidence of these responses is so similar to that of the discarding responses and "blanks" of the preceding chapter that it needs no further comment. It should be noted, however, that blanks and the removal of false hypotheses were not always followed by new responses. Sometimes blanks persisted for several reactions and the subjects merely modified

some old method of procedure before really new plans occurred to them.

D. *Generalization of Two Generalizations*

This response has been referred to in two preceding chapters: in the chapter on participant behavior, where it appeared as one of the reasons for changing a reaction after a success; and in the chapter on synthesis, where it was included among the processes producing that result. It therefore needs no discussion or illustration here. It is necessary only to note that it gave the subjects a perception of a rather high order—a perception of the "principle" that one figure determined which symbol was used and the other where it was placed. Of course it was considered a new response only the first time a given subject used it; and its frequency, with this qualification, is limited to three cases.

E. *Clues*

There were 11 instances[4] in which new responses came into the situation as the result of clues. The most interesting feature about these cases is that the clues were not always immediately effective—not even when they were positive suggestions. There were some cases, of course, where the correct response was suggested at once, but occasionally the first effect of a clue was to produce a "blank."

Clue: "You were right, earlier in the problem, when you thought of putting the sign of one figure inside the other."
36.—22.8 sec.—"Then I don't get it at all. All those I've had right have been when I marked a figure with its own sign. This means nothing. I just marked it." (Wrong)
37.—3.2 sec.—"I still don't see what it is." (Wrong)
38.—18.7 sec.—"Oh! Maybe you give it its own sign when the curve is underneath and when it is on top, you give it the other sign." (Right)

Subject E—Problem A IV.

Clue: "Use the concept of number."
48.—42.3 sec.—"The concept of number. I don't see what that could be unless you mean the order they followed in the original series. I think the circle came before the diamond, so I marked that. I'm pretty sure the circle came first." (Wrong)

[4] All together, there were 20 clues given in the experiment, but only 11 of them resulted in *novel* responses. For conditions in which clues were given, see Chap. I, p. 24.

49.—106.0 sec.—"I believe it is the number of separate strokes used for each figure. I put the insert in the one that has the greatest number of separate strokes." (Right)

Subject G—Problem A III.

The form in which the clues were given made little difference in their effectiveness. There were no distinctive modes of response to the elimination of false hypotheses, to the confirmation of true ones, or to direct suggestions. The incidence of these responses is without significance, since their distribution was determined by the rule that clues were to be given only after a subject had worked for an hour on a problem without solving it. Consequently they always occurred late in long and difficult problems.

F. *Combinations of Various Processes*

There were many cases in which new responses came into the situation as the result of a combination of processes in which some of the more complex forms of analysis and synthesis were present. It is practically impossible to single out any one process as responsible for the new reaction in a particular case, and consequently no attempt has been made to analyze the situation beyond the complex of activities involved in "thinking out" a situation. These responses varied in degree of complexity, but were similar in attempting to collect all the available evidence and bring out its implications.

5.—92.5 sec.—"Let me see. I had two right and two wrong. Both of those I had right were when I marked the underneath figure, but one of the wrong ones was the underneath figure, too, I think. Therefore, I knew it couldn't be simply the underneath figure. Besides, it might have been number of sides or curves or something like that that made them right, but I couldn't remember how they all looked and couldn't get anything that way. I knew it couldn't be just number of sides, though, because the two I had wrong prove that. Then I thought it might be some kind of combination principle like marking the under when it was greater or smaller number of sides and otherwise mark the other. I thought that combination principle was a pretty good idea, so I marked the under figure with smaller number of sides, to see if it will work out that way."

Subject E—Problem A IV.

In their distribution, these responses resemble "deliberate analysis" and some of the more complex forms of synthesis. They frequently appeared in first reactions, especially if the situations were presented with aids. After first reactions,

they appeared only in problems where both successes and failures were possible and seemed to be stimulated by a variety of circumstances. Either an unexpected success or failure seemed particularly likely to catch the subject's attention, arouse him to a close inspection of the situation, and stimulate him to bring as much evidence as possible to bear on the matter. The perception of a difference in the objective situation sometimes had a similar effect.

It is worth noting that when a subject was experiencing a long series of failures, this complex response did not occur. Like most forms of analysis, it required the presence of a considerable mass of content, and the effect of continued failure was to exhaust the supply of responses. "Thinking out" a situation seemed to require as its basis the possession of a few positive facts, which, in the ignorance induced by the conditions of this experiment, could be supplied only by clues or occasional successes. Mere difficulty, felt as such, did not initiate the process; only a difficulty with a very definite content could do so. But no situation could be recognized as presenting a concrete difficulty, unless contrasted with other situations which gave success. The essential condition seemed to be the emergence of certain definite facts, which could be examined in relation to the total situation. But facts might acquire definiteness and emphasis through success, or mere difference, as well as through the experiences of difficulty and failure.

This result suggests a comparison with Dewey's view that felt difficulty is the natural stimulus to thinking.[5] It is to be noted however, that the problems which Dewey had in mind concerned matters of which the thinker was not entirely ignorant; that is, the difficulty emerged from definite knowledge which the subject had on hand. Therefore the knowledge as well as the difficulty may possibly be an essential part of the situation, and it would seem that a certain amount of previous success in handling some of the facts in question is presupposed in Dewey's analysis. In this experiment, where the subject is reduced to ignorance,—that is, to a condition in which he has had no previous success in handling the material, —existing knowledge cannot be taken for granted. Con-

[5] Dewey, "How we Think"—pp. 72, 73.

sequently the role of successes, which might be overlooked where knowledge is present, becomes especially conspicuous.

Ruger, too, emphasizes difficulty as the stimulus to thought,[6] or analysis, in the sense in which he uses the term. But his situations, too, though novel, employed the materials of everyday life and consequently made some connections with existing knowledge.

G. *Responses Reported without Explanation*

In a fairly large number of cases, the subjects reported new responses which they did not account for in any way. They described them simply as occurring—often as suddenly occurring.

17.—8.1 sec.—"There it suddenly occurred to me to mark both, so that's what I did."

Subject D—Problem A VI.

11.—14.7 sec.—"I thought I'd try using the mark of one figure for the other. I don't know why. I suppose that's foolish though, because it has always been right to give a figure its own sign. But I just happened to think of it, so I used it."

Subject E—Problem A IV.

In these reactions, the variations came without warning, but were noticed after they appeared, resembling, in this respect, the majority of the variations reported by Ruger. In incidence, they are rather like the responses following the removal of incorrect hypotheses—a fact which suggest that both kinds of reaction may involve the opening up of new fields of possibilities when old lines of action are proving fruitless. But in the reactions of this class, the transition seems more immediate, and the circumstances which attend it escape notice.

H. *Responses Unobserved by the Subjects*

Finally, there was a group of responses which the subjects did not notice either at the time of their emergence, or after they had appeared. The reactions of this class were methods of procedure, rather than new hypotheses or discoveries about the objective situation. In the cases cited below, the subjects were apparently unaware of the fact that they were intro-

[6] Ruger, op. cit. p. 33.

ducing new methods into their procedure, though, as a matter of fact, they were using certain devices for the first time,—the cleavage response in the first illustration and the defining response in the second. Even after they had used these and similar devices, the subjects themselves usually did not observe them as definite modes of behavior, in spite of the fact that the reports were given in such a form as to show that those reactions were present.

11.—13.2 sec.—"I know that when the under figure is curved it is right to give it its own mark. When it is straight, I'll try giving it the mark of the other."

Subject K—Problem A IV.

18—.18.2 sec.—"I am marking upper, straight, many sided, with its own sign, and remembering that the lower one is curved."

Subject D—Problem A VI.

Other responses belonging to this class are the location of a difficulty, deliberate analysis, the assembling of a group of possible hypotheses, discarding activities, organized search, plans for the future, etc. In most of these cases, the subjects did not seem to be distinctly aware of the devices they were using, even after they had used them repeatedly.

The responses of this group possess three principal characteristics.

1. They are manipulative rather than perceptual. They do not give rise to new ways of seeing the situation,—as composed of straight and curved lines, for instance,—but to novel ways of dealing with situations which continue to be perceived in the old ways. The cleavage response, for example, is a way of classifying the data, and the defining response a way of isolating the particular circumstances in which a given reaction is right or wrong.

2. As manipulative rather than perceptual reactions, their primary stimuli are not in the objective situation but in the reacting organism. The perception of straight or curved lines, for example, is stimulated rather directly by certain features of the objective situation; whereas the defining response, which represents reactions of the other group, is usually initiated by a feeling of difficulty induced by a series of failures and a consequent exhaustion of the supply of possible modes of reaction; in other words, by subjective conditions. The fact that manipulative devices are less immedi-

ately connected with the objective situation may account for their tendency to escape notice. Since attention is likely to be centered on the objective situation, events only remotely connected with it are at a disadvantage, so far as attention value is concerned.

3. The unobserved reactions are less completely under the control of the subject, less transferable from one situation to another, than are the observed reactions. For example, a subject, having discovered the distinction between straight and curved lines in one problem, tries it out in almost every problem that follows; whereas one who has used the defining response uses it only when stimulated by the same feeling of difficulty and the same poverty of ideas that aroused it in the first place. Perhaps this fact is due to the complexity of the conditions by which the manipulative responses are aroused. The subjective factors which surround a reaction at any given time are not simple; it is difficult to isolate the effective stimulus from the total situation; and in consequence, the stimulus-response connection is less clear-cut and definite than in a perceptual reaction stimulated by some one feature of the objective situation. The more complex and less perfectly isolated connection would naturally be less manageable and less transferable.

It is interesting to compare this situation with the previously mentioned results of Swift, Book, and Ruger. In the work of Swift and Book, improvement was largely a matter of motor manipulation, and the variations, which of course had to be supplied by the reacting organism, were usually unobserved and were more effective when unnoticed; that is, they were not directly controllable by the subjects. In Ruger's work, too, variations in motor performance had to be supplied by the organism, but they also had to be connected with specific features of the perceived situation; and here though the coming of variations was usually unobserved, they were sometimes noticed after they had taken place, and were found to be more transferable and generally more controllable if they were noticed, analyzed, and formulated. Both these sets of facts are in harmony with the results of the present study, where, as the variations become less manipulative and more perceptual, they become more observable, and more controllable. That is, the stimulus-response connection determines

both whether a variation shall be observed and whether it shall be effectively controlled. If it is stimulated by a particular feature of the objective situation, it is both observable and controllable; but if it is aroused by complex organic conditions, it is as a rule neither observed nor controlled.

No quantitative comparison of observed and unobserved responses was attempted, principally because of the difficulty of identifying novel reactions not mentioned by the subjects themselves. Definite modes of behavior, like those involved in defining and cleavage responses, for example, are easy enough to detect; but since every new attitude or shift in orientation is, in one sense, a new response, an attempt to establish the limits of this class would be a very subjective affair. It was considered advisable, therefore, to attempt no exact comparison, but simply to note the existence of both kinds of variations and to point out the difference between the two classes.

Summary

As regards the conditions in which new responses occur, again the outstanding fact is the variety of processes by which they enter the situation and the diversity of the conditions which stimulate them. They may occur as the result of observation, summation, removal of interferences, clues, generalizations, and "thinking out" the situation.

However, there are two facts regarding the manner of their occurrence which deserve special emphasis. The first is the fact that there is good evidence for the production of new responses through the summation of impressions not specifically attended to. This is important as a line of evidence in support of the existence of spectator behavior—or rather, it gives spectator behavior a reason for being, since the spectator attitude is a preparatory reaction for just this kind of event. The second is the role of successes in inducing new ideas—particularly in inducing the response of thinking out the situation. This fact is emphasized, not because successes are intrinsically more important than other ways of producing the activity, but because the opposite conditions of difficulty, blocking, and failure, are the points more commonly stressed.

It is also to be noted that this experiment brings out both observed and unobserved variations. The evidence indicates

that new responses tend to be observed when they are perceptual and aroused by particular features of the objective situation; unobserved when they are manipulated and initiated by complex conditions within the organism itself. As regards the amount of attention which variations may profitably receive, this study confirms Ruger's results in showing that the observed variations possess greater transfer value. As regards the amount of attention they actually receive, it goes a step farther and shows that the first appearance of a variation, as well as its subsequent use, is often definitely noticed.

Finally, it is worth mentioning that none of the means by which variations are brought into the situation is different from the activities regularly present in thinking. So far as the evidence goes, there is no special process or particular set of circumstances by which novel responses are introduced.

CHAPTER X

Orientation toward Problems as Total Situations

The detailed processes and the general attitudes do not tell the whole story of what goes on in thinking. In connection with each problem, there is an adjustment to the particular features of the situation which forms a setting within which the other activities occur. This adjustment is more specific than the general attitudes and more general than the detailed processes. It is something which the subjects do not mention themselves, but which an observer may notice either from their behavior during the actual performance or from the record which the performance leaves.

Even if a single reaction is taken by itself, a certain amount of organization appears. The subject definitely, and apparently automatically, keeps his bearings within the limits of a single trial. There is, roughly, a distinction between what is essential and what is incidental. However, the organization of the responses about a single overt performance has been taken up in the preliminary survey[1] and need not be reviewed here.

There is also an orientation toward each problem as a whole. The subjects behave differently toward different kinds of problems. The procedure is not the same in problems with and without clues, and the general line of attack varies with the nature of the aids given. In fact, it is in this matter of orientation that the influence of aids principally shows itself. The same fundamental processes may appear in different problems, but the organization of those processes, the way in which they are held in line, varies from problem to problem.

There are two ways in which different kinds of orientation reveal themselves: (1) the differences in reactions time curves; and (2) in differences in general procedure. Typical individual reaction time curves are given in the aaccompanying table; and in the remainder of the chapter, the typical procedure for each kind of problem is roughly outlined.

[1] See Chap. II, p. 40 ff.

Reaction Time Curves

==indicates the solution.

Class A

(a) Problems including Successes and Failures

A IV	*A III*
9.2	5.0
7.8	4.8
37.9	7.2
39.2	34.3
14.2	15.2
17.5	12.2
5.1	9.8
6.1	11.8
11.9	7.0
39.7	27.5
19.1	4.0
36.0	9.9
35.8	15.1
143.5	7.5
11.8	==
13.8	3.0
8.2	3.8
9.8	2.8
4.8	3.1
13.5	3.4
26.9	
8.5	
3.5	
35.5	
17.8	
68.5	
52.9	
17.2	
45.8	
3.2	
5.4	
4.2	
38.2	
49.2	
7.1	
9.8	
8.2	
8.2	
28.2	
8.4	
31.9	
29.7	
26.2	
10.9	
==	
5.6	
4.1	
3.8	
5.1	
3.0	

(b) Problems including only Failures

A VI	*A I*
7.0	9.8
7.6	5.2
16.0	7.4
13.9	17.2
14.8	29.1
38.4	15.1
54.0	9.0
27.4	23.9
82.5	4.4
90.5	15.1
56.4	16.7
34.5	17.8
29.9	19.1
42.5	8.2
15.0	4.4
79.3	18.0
27.0	13.2
25.6	3.6
22.0	21.0
51.0	38.2
18.3	9.1
56.9	6.2
58.0	5.6
102.1	14.7
4.1	65.2
34.4	39.2
7.5	39.4
3.2	37.5
3.6	38.3
4.0	==
28.2	2.4
138.2	2.0
32.4	3.0
==	1.5
9.1	1.4
3.4	
4.8	
4.2	

Class B

B I	*B II*
22.0	19.5
7.5	2.0
5.1	6.0
5.2	3.0
4.3	2.9
17.8	28.5
==	14.1
5.2	16.2
4.3	14.8
5.1	5.2
4.1	7.2
	20.9
	19.8
B III	4.8
12.2	35.3
6.1	38.0
6.2	51.6
6.8	4.3
4.5	4.3
68.9	17.4
17.6	==
==	3.7
7.2	3.8
5.1	4.3
5.1	3.1
4.3	3.7

Class C

C III	*C IV*
141.8	35.1
==	34.9
7.9	9.0
7.0	6.8
7.6	52.2
5.2	==
	7.0
	5.4
C I	5.2
18.9	4.6
5.2	
4.6	
12.3	*C V*
20.7	317.2
14.6	30.0
==	12.8
4.7	29.0
5.1	27.8
3.2	14.7
3.8	29.6
3.0	==
	8.1
	7.8
	7.8
	6.4
	6.7

Class D

D I	*D II*
45.3	35.8
20.3	5.6
==	7.0
6.4	==
7.3	4.0
7.8	3.6
5.9	2.1
	3.9
	2.0
D I	
125.7	
8.7	*D II*
6.4	77.8
83.0	45.2
64.6	26.5
20.5	==
==	6.5
7.6	5.7
4.7	3.7
4.8	4.8
5.0	

Class E

E I	*E II*
9.0	8.5
13.9	15.8
23.0	39.3
6.5	32.4
12.4	77.2
==	34.8
4.8	31.7
4.0	41.5
2.5	==
4.5	5.8
	4.1
	3.8
	3.9

Class A

I. *Situation:* Problems presented without aids of any sort.

II. *Procedure.*

The problems of this class are of two sorts: (a) those in which both successes and failures occur; and (b) those in which only failures are possible until solution. Since the procedure is different in the two cases, each kind of problem will be treated separately.

(a) Procedure in problems including both failures and successes.

1. No careful examination of the situation before overt reaction, except in rare cases. Immediate participant attack, in which two or three reactions are made, evidently exploratory in function. Rather short reaction times.

2. An analysis of the situation in about the third or fourth reaction, especially if both successes and failures have been encountered. An increase in reaction time.

3. A period of no fixed duration in which regularity of procedure disappears. Reaction times irregular in length.

During this period the subject becomes absorbed in the details of the situation. His reactions are determined by stimuli which emerge from moment to moment rather than by the nature of the problem as a whole. A great variety of processes occurs. Long reaction times frequently mean the more complex activities of analysis and synthesis. A series of short reaction times usually indicates a partial solution of the problem in the sense that the subject has learned how to respond to situations of a particular sort.

4. The discovery of the correct response, or solution. Return to regularity of procedure. Short and regular reaction times.

(b) Procedure in problems including only failures.

This procedure is like that just outlined as regards the first and fourth steps. The difference lies in the middle portion. Here the procedure becomes very simple in general principle—to try out one hypothesis after another until the solution is found; but the activity gives the impression of being strenuous, though not elaborate. The long reaction times usually mean difficulty in thinking of hypotheses to try.

The short ones indicate repetitions of incorrect hypotheses, or spectator behavior. The higher forms of analysis and synthesis do not commonly appear.

Class B

I. *Situation:* Problems, each of which is a combination of two situations previously mastered, presented after the subject has reviewed the rules for the component situations and has been told that both rules may be used. "Conflict" situations are not presented until "no-conflict" situations have been correctly marked five times in succession.

II. *Procedure*

1. Analysis of the situation before overt reaction. Relatively long first reaction time. Usually little difficulty in applying both rules to the situation. Success in second or third trial if not in first.

2. A series of successes during the presentation of "no-conflict" situations. Reaction times like those following solution of a problem. General attitude like that following solution, except for occasional anticipation of complications in the near future.

3. Deliberate analysis, precipitated by the presentation of the first "conflict" situation. Lengthened reaction time. Frequently a statement of the problem in the form of a dilemma, and a subsequent trying out of the two possibilities, one of which usually gives the solution. In case of inability to make a satisfactory analysis—as happened most frequently in Problem B II—a practical resolution of the problem into one of unaided type in its middle stage.[2]

4. Solution. Same as in problems of Class A.

Class C

I. *Situation.* Problems with definite clues. Each problem is accompanied by at least one correctly marked sample card, sometimes by more than one, and sometimes by incorrectly

[2] This stage sometimes lasted a long time, as the subject was completely bewildered when he found himself unable to make use of the clue. Reaction curve II B represents an approximation to this condition.

marked samples in addition. The subjects are always told which markings are correct and which incorrect.

II. *Procedure*

1. Careful analysis of the sample cards before overt reaction, especially if two or more are used. Long reaction time.

Several features of the analysis occurring in the first reactions of these problems ought to be mentioned.

(1) The greater the amount of evidence presented, the more careful and detailed the analysis. The more elaborate forms of reaction, such as "deliberate analysis" and "organized search" are likely to appear only when two or more samples are present. The examination of a single sample card is rather a cursory affair.

(2) Even when the analysis is thorough and detailed, it is not always carried through until the subject feels that he has made use of all the information available. Several subjects said that they preferred to try out a few possibilities rather than "bother to think it all out."

(3) No matter how complete the analysis, there is usually only one complete hypothesis formed during the first reaction. That is, there is a kind of economy of effort in eliminating certain points as irrelevant before formulating a complete theory of action. Instead of forming a hypothesis outright and testing it as a whole, the subjects first test the raw material of which it may be made—for example, to see "if it has anything to do with the number of sides."

(4) The subjects examine the incorrect markings only after they have studied the correct ones, or else do not use them at all.[3] This fact may be significant in connection with the analysis-value of successes in general, for here, where the subjects have both artificial successes and artificial failures at their disposal, they use the successes in preference to the failures as the basis of their activities.

2. Continued analysis until solution. Usually fairly long reaction times. Sometimes a series of short reaction times

[3] This point is interesting in connection with a fact observed by Kuo, who found that his subjects displayed a tendency to ignore negative instances and to limit their attention to positive cases. Kuo, a Behavioristic Experiment on Inductive Inference, J. of Exper. Psychol., 1923, 6, p. 283 ff.

when the subject has made an anlysis covering a certain kind of situation and thinks the problem solved until be encounters a situation of another kind.[4]

3. Solution. Same as in other problems.

Class D

I. *Situation:* Problems with indefinite clues; that is, two or four samples, presented with the instructions, "One of these is right; the others are wrong." The correct one is not specified.

II. *Procedure*

1. An examination of all the sample cards and the formation of a complete hypothesis to account for each, before the first overt reaction. Long reaction time.

2. The trying out of the hypotheses in turn, usually following the objective order of the sample markings from which they are taken. Sometimes continued analysis, during which other hypotheses are formed to account for the sample markings, the period of analysis sometimes continuing for a long time if the hypothesis suggested by the correct sample does not happen to be the one the experimenter intended. Long or short reaction times according to the presence or absence of continued analysis.

An important variation which sometimes appears in the general procedure should receive special mention. Some subjects try to eliminate possibilities without actually trying them out. Instead of following the order of the samples, they try to discover an order of probability. For example, "I didn't think you'd put the right one either first or last, and the second one was too much like one we had before, so I marked it like the third one."

3. Solution. Same as in other problems.

Class E

I. *Situation.* Two problems, in one of which the subject is told which particular features of his reaction are right, in the

[4] See reaction curves C I and C IV.

other, which ones are wrong, regardless of the correctness or incorrectness of the performance as a whole.

II. *Procedure*

The procedure is practically the same as that in the unaided problems. This is probably due to the fact that the aids consist merely in emphasizing processes which would occur without them—the conservation of correct responses and the elimination of incorrect ones.

Orientation toward Problems in First Reactions

Since differences in orientation are first shown by adjustments made during first reactions, the following table is presented as a kind of summary.

Class	*No. of Problems*	*Deliberate Analysis*	*Organized Search*	*Assembly of Possibilities*
A	60	7		12
B	30	28		
C	50	33	6	
D	20	20		
E	20			2

This indicates what has been brought out before in several ways, that the more complex reactions of "deliberate analysis" and "organized search" are stimulated when a certain amount of information accompanies the presentation of a problem; and that when the problem is presented without information, the subject rarely stops to make a careful examination of the objective situation but responds either by beginning participant behavior at once or by assembling his own repertoire of responses as possibilities of action.

Summary

The general result of this study is to bring out the existence of a definite and apparently automatic orientation to a situation as a whole. In some respects, it resembles the ad-

justment to the "task" studied by Watt[5] and May.[6] In the work of those writers, however, this process was made the special object of investigation, whereas, here, it came out incidentally as one of the many activities involved in thinking. It appears, therefore, not as an isolated process but in its general setting; and shows how changes in adjustment are taken on naturally in response to the changing demands of the situation. In the work of Watt and May, the differences in the tasks were clearly indicated in the instructions, and it was discovered that the subjects responded with definite adjustments which continued to be effective even after they had been forgotten. The present study shows that adjustments may be automatically adopted as well as automatically maintained. The fact that they were aroused by complex situations, not especially designed to bring about differences in procedure—and certainly not labeled as requiring changes of that nature—makes their discriminative character and prompt effectiveness the more evident.

[5] Watt: "Experimentelle Beiträge zu einer Theorie des Denkens," Arch. f. d. geo. Psychol., IV, 1905, pp. 298, 418 ff.

[6] May: "The Mechanism of Controlled Association," Arch. of Psychol., No. 39, pp. 25-32, 73-4.

CHAPTER XI

The Solution of a Problem

The solution of a problem, as the term is used in this experiment, was defined as that point at which the subject formulated a rule which would give successes consistently, made an overt reaction on the basis of that rule, and followed his discovery with at least four successful performances. The question now arises: does this point, arbitrarily determined by the rules of the procedure, represent any definite event in the experience of the subject? Does the subject himself know that he has passed a milestone?

There are two lines of evidence which tend to show that he does. The first is that, in the great majority of cases, the reaction time curve is distinctly different before and after the solution. The second is that there is a marked change in the subject's general behavior after the solution has been reached. The things which claimed his attention a moment ago no longer concern him; he seems to be engaged in a different kind of enterprise.

I. *Changes in Reaction Time*

The curves given in the preceding chapter show what happens to the reaction times. Briefly, the reactions suddenly become shorter and more uniform. In 83 per cent of all the problems in the experiment, there is a sudden drop in the curve immediately after solution, and a marked decrease in variability. Before the solution of a problem, there may be occasional reactions as short as those that follow the solution, and in rare cases, there are long reactions after the solution; but the outstanding difference between the two portions of the curve lies in the great irregularity of the one and the relative uniformity and promptness of reaction indicated by the other.

This result is in agreement with that obtained by Ruger in his study of the solution of mechanical puzzles and in contrast with the gradual decrease obtained in most learning

curves. Ruger[1] found that in 78 per cent of the cases, sudden drops coincided with "conscious variations" or "analyses" or "insights." Ruger seems to interpret these events as indicating various degrees of understanding of the situation. But in the present experiment, the mere presence of a drop in the reaction curve cannot be regarded as indicating an understanding of the situation—at least not until several other lines of evidence have been examined.

As a matter of fact, on certain occasions *before* the solution has been reached, there are series of reactions which display the characteristic brevity and uniformity of those following the solution.[2]

1. Some of these are due to partial solutions of a problem. Partial solutions occurred in problems of two sorts: in those of Class B, where the procedure provided that the "no-conflict" situations be met with five successful responses before the "conflict" situations were introduced; and in various problems of other classes where, by means of a cleavage response, the subject divided the situations into two classes and learned how to respond correctly to one class. Consequently, whenever two or three situations of this class came in succession, they were met promptly and the corresponding reaction times were short and regular. It is not surprising that this is the case; in fact so far as those particular situations were concerned, the problem was solved, and naturally the performance presents the features of a solution.

2. The reactions belonging to a series initiated by a "specific plan for the future" were also short and regular. Here the subject rapidly ran through the several possibilities he had thought of and the result was a reaction time curve like that following a solution. But here the reactions were all failures rather than successes, since a plan of this sort would obviously be discontinued as soon as the subject discovered that one of his hypotheses was right.

3. A third event which gave a series of prompt and regular reactions was the adoption of the spectator attitude. Since the spectator attitude was generally used when the subject was in difficulty and could think of nothing to do, it is about

[1] Ruger—op. cit.—p. 51 ff.

[2] The curves given in the preceding chapter show some of these series of short and regular reactions. See p. 147.

as far removed from the solution of a problem as any event in the experiment. Besides, a series of spectator responses is not a series of successes. It usually includes both failures and successes and is sometimes composed of failures exclusively.

Thus there are four situations—three besides the solution—which are objectively similar, so far as reaction times are concerned, but which evidently represent different subjective situations. But there is one point of similarity, even in the subjective situations, since in all these cases, the subject knew what to do next. In the spectator responses and in the plans for the future, he had decided what to do, even if he had not discovered the right response and in the solutions and partial solutions, since he knew the right thing to do, he could react promptly, without inventing a new course of action or considering possible alternatives. A sudden drop in reaction time, therefore, even if it is consistently maintained through a series of reactions, does not indicate, in and by itself, that the situation is understood. It does not even mean that the subject knows the *right* thing to do next. It simply means that he does not have to change his mode of reaction each time a new situation is presented. The essential difference is that before solution, the subject is repeatedly shifting his set; after solution, he maintains the same set. Anything that will permit him to maintain the same set, apparently has the same effect on reaction times; but knowing the solution of the problem is probably the method par excellence of maintaining the same set.

It is probably well to note, in this connection, that the general result of formal reaction time experiments, where sets permitting various degrees of definiteness of preparation are induced by assigned tasks, is confirmed in this material, where the obtaining of reaction times is incidental, and where the different sets are taken on by the subject himself, as adjustments to situations which change from moment to moment, rather than in response to formal instructions. It is probably well, too, to mention the similarity to Metcalf's[3] result that speed was one of the two best indices of confidence, since solving a problem would imply at least as much confidence as is necessarily involved in having the response ready.

[3] Metcalf, An Experimental Study of Conscious Attitude, Psych. Rev. Monog. Suppl. 1917-23, p. 235 ff.

II *Changes in General Behavior*

But, on the whole, the change in the reaction time curve cannot be regarded as an indication sufficient in itself to show that a solution, in the sense of an understanding of the situation, has been reached. However, the objectively determined solution is usually accompanied by an abrupt change in the general behavior of the subject, which leaves little doubt that he has encountered an experience which has made a distinct impression. He ceases to do many of the things he did before and begins to engage in other activities which did not appear before that time.

The most conspicuous difference is that the amount of material that he reports suddenly decreases in volume. In most cases, before the solution of a problem, the subject states the hypothesis on which he is acting, and usually has some supplementary material to add—secondary hypotheses, observations and considerations of various sorts, and sometimes the more complex activities of analysis and synthesis. But after solution, the report is generally limited to the mere statement of the hypothesis—or rather to an indication of the hypothesis, for an actual statement of the complete hypothesis is a rare occurrence after the problem has been solved. The subject's report is usually limited to some phrase like "I marked it the same way," or merely "Same thing" or "Same." Sometimes it is a shortened statement of the hypothesis like "Curves" or "More sides." One subject, after solving a problem usually said "Automatic," and others would frequently say "Nothing" or "Nothing to report" or "Nothing more." In case the problem was one which divided itself into two situations, each of which had been solved separately, the solution was usually stated in compound form; for example, "When the curve is underneath, mark it with its own sign; and when it is on top, with the sign of the other." In these cases, after solution, the subject would simply say, "Curve underneath," or "Curve on top" and give no further explanation. Sometimes a solution of this kind would be formulated as a rule with an exception, as "Mark the curve with the sign of the figure that is underneath, unless the curve is underneath. Then give it its own sign." In cases of this sort, the report after solution would sometimes be merely "Rule" and

"Exception." The general tendency is clearly to shorten the process as much as possible—a tendency which evidently holds in these activities as it does in the field of motor learning where the elimination of superfluous activities and the consequent gain in precision of performance is an established fact.

This does not mean however, that immediately after the solution of a problem, all thinking ceases. For one thing, the hypothesis on which the subject is acting sometimes undergoes certain improvements. There were 22 cases in which this happened. In 5 of these, the improvement took the form of a generalization and simplification—the kind of reaction described in the chapter on synthesis as a "generalization of two generalizations." The cases referred to in that chapter coincided with the solution, but there were also cases which occurred after the subject had solved the problem and had made several reactions on the basis of the compound rule. In 11 cases, the hypothesis was not changed in formulation, but was verified as it stood. In these cases, the subject, realizing that there were other possibilities, identified a "test case," and used the outcome to verify his theory. In the remaining 6 cases, the subject expressed vague doubts about his hypothesis, but gained confidence in his theory merely because it continued to give success, not because he had succeeded in actually verifying it in a test case. "I don't know whether I got everything in," "There may be something more to it," and "I don't feel as if I have exactly solved anything" represent attitudes which apparently disappear in the face of continued success. Cases of this sort account for some of the reaction time curves in which sudden drops did not coincide with the objective solution; but in some cases the overt reactions were short and regular, in spite of the fact that the subject was not sure that he had "exactly solved anything."

In all these activities, the subject's attention was plainly directed toward the successful hypothesis; but in other cases, the hypothesis seemed to retire to the background and other matters claimed attention. There were 13 cases in which rival hypotheses suggested themselves and were kept in readiness in case the primary hypothesis failed. There were 5 cases in which the subjects anticipated possible changes in the situation which would necessitate modifications of the current

hypotheses; and there were 31 cases in which the subjects observed facts quite unconnected with their hypotheses. These observations were usually of a trivial nature in the sense that the subjects themselves attached little importance to them. They were likely to be comments on details of procedure, or peculiarities of the drawings or symbols; for example, "Isn't this a funny little symbol? How did you happen to think of it?" or "These two figures go well together. They give a symmetrical effect." Sometimes the comments strayed so far afield as "I noticed six empty ink bottles on the shelf and wondered why you didn't throw them away," or, after a glance out of the window and across the street, "Aren't apartment houses ugly?" In some cases, too—in 18, to be exact—speculations about the general nature of the experiment occurred, as if, released from the immediate demands of the situation, the subjects were free to reflect on that topic. All these cases are similar in the sense that the subject was no longer concerned with the hypothesis he was using, but let his attention turn to other matters. All of them, too, were like activities that occurred before solution—observations, new hypotheses, anticipations of the future, and speculations about the experiment as a whole. In a sense, they show that a subject's activity was not entirely different before and after the solution. Yet the attitude toward these same events was different. The hypotheses were not utilized; the observations were regarded as incidental; and all seemed to be recognized as side activities.

In addition to these reactions, there were occasionally responses which seemed to indicate relief or pleasure or satisfaction in the solution. The solution was sometimes accompanied or followed by observable physiological reactions indicating a relaxing of tension. There were often sighs or smiles, in a few cases slight laughter, and on one occasion actual shouts. The last named reaction occurred after the subject had worked for an hour and a quarter on a problem and, without achieving a single success, had made 37 reactions, many of which were long and strenuous. Sometimes there were verbal expressions of satisfaction such as "I'm glad that's over," or "It's a relief to have that out of the way," or "Wasn't that a wicked one? But fortunately, it's over."

These facts are briefly summarized in the following table:

Total Number of Reactions after Solution	891
Activities directed toward successful hypothesis	
Generalization	5
Verification	11
Doubts dispelled without verification	6
Total	22
Activities unconnected with successful hypothesis	
Other hypotheses	13
Observations	31
Anticipations	5
Reflections on nature of experiment	18
Verbal expressions of relief	18
Total	85

That is to say, the solution marks a definite turning point in the behavior of the subject. His activities diminish both in quantity and in complexity, and for the most part, lose their utilitarian character. Incidentally, their presence shows that there are some activities which do not require the stimulus of failure and may occur when the stress of circumstances does not actually require them.

It is interesting to note that similar changes in behavior occurred in the other cases, besides solution, which gave the change in reaction time. In all of these events, there was a prompt decrease in the amount of content reported; but in the specific plans for the future and the series of spectator reactions, the similarity stopped at this point. In other respects they showed no resemblance to the conduct following solutions. The partial solutions, however, induced some of the same reactions which followed complete solutions, notably the occurrence of detached observations, of other hypotheses, and of anticipations of future complications. Occasionally, but less frequently, there were expressions of relief and reflections on the general nature of the experiment. There were no attempts at verification, though sometimes doubts were expressed as to whether or not the partial solution was really significant.

III *Processes by which the Solution is Reached*

Since the solution is a definite turning point, the question may arise as to whether there is any characteristic way in which it is reached—whether the processes by which it is

brought about are different from processes involved in other parts of the problem and, because of their difference, make the solution a distinct experience.

All together, there were 178 solutions in the experiment. Two of the 180 problems attempted were not solved. In a sense, the solution is the result of everything that has gone before, but if this point is ignored for practical reasons, and the 178 available cases analyzed with respect to the processes immediately preceding them and presumably immediately responsible for them, the following results are obtained.

Methods of Reaching Solutions.	*No. of Cases.*
1. By cleavage responses plus participant variations	49
2. By participant variations	35
3. By deliberate analysis	28
4. By "simply occurring" (often after "blanks")	23
5. By clues	20
6. By summation[4]	15
7. By a generalization of two generalizations	3
8. By organized search	3
9. By convergence of two responses	2
	178

All these terms will be recognized as familiar with the possible exception of "participant variations." This phrase denotes a very simple and common form of participant behavior which consisted in a trial-and-error manipulation of the material on hand, by means of varying hypotheses slightly, without introducing anything essentially new. For example:

2.—8.3 sec.—"Double figure when it is on the left."
3.—5.2 sec.—"Double figure when it is on the right."
4.—11.2 sec.—"Double figure when it is curved."
5.—14.6 sec.—"Double figure with the sign of the other when it is curved."

Subject K—Problem C III.

In this way, the simple participant procedure sometimes gave the solution.

The general result, then, is that no processes are at work in producing the solution which are not involved in the formation of other hypotheses during the course of the problem.

[4] Two cases of summation followed immediately upon spectator behavior; the others came in the course of participant behavior and were apparently due to participant and spectator activities combined.

Nothing distinctive in the manner in which the solution is reached explains the fact that it constitutes a clear cut experience.

In the table given above, the processes resulting in solutions are arranged in the order of their frequency. This arrangement would assign a large role to trial and error—as represented by participant variations—since it is responsible, wholly or in part, for the two largest classes. However, this order cannot be taken too seriously, since the method of solution was largely determined by the nature of the problem; and the number of problems of each sort which happened to be included in the experiment may arbitrarily determine the rank of a given process. For example, most of the summation solutions occurred in Problems A II and A III, where concepts not previously used in the experiment had to be evolved from the general trend of the evidence; and the solutions which "simply occurred" were most frequent in Problems A I and A VI, where a continuous series of failures steadily eliminated possibilities of action and kept the field clear of interferences. A different selection of problems would doubtless have changed the rank of the processes. The outcome of the analysis, therefore, is not to establish the relative frequency of different methods of solution, but to bring out the following facts: (1) that a solution may occur in several different ways, (2) that there is nothing new or distinctive about the processes which bring it about, and (3) that the various processes are adapted to various conditions.

Summary

Briefly summarized, the results of this study are (1) that the solution of a problem is a very definite event in a subject's activity and (2) that, in spite of this fact, it is not effected by a special process or group of processes.

The fact that it marks a definite turning point is shown objectively by a marked change in the reaction time curve, and an equally marked change in general behavior. But there is no evidence to show how the subjects recognize the fact that a problem is solved. It is fairly clear, however, that it had nothing to do with the way in which the solution is reached, since there is no discoverable difference between the ways in

which subjects form incorrect hypotheses and those which constitute solutions.

The many different processes by which the solution may be effected constitute another line of evidence that the nature of a process cannot be inferred from the nature of the result produced. Just as a common result—analysis, for example—may be accomplished by many different methods, so the event, whatever its nature, which constitutes the solution of a problem may be brought about in a number of different ways.

CHAPTER XII

The Complete Act of Thought

Up to this point, the processes involved in thinking have been studied separately. Very little has been said about entire trains of thought. It is possible, however, to regard each of the 180 problems of the experiment as a unit—or, in Dewey's[1] phrase, "as complete act of thought,"—and to find out what is included in such an activity when it is empirically determined.

Briefly stated, the result of such an examination is that there is nothing to be found which can be identified as a complete act of thought. There is no series of events, no set of requirements, no pattern of behavior, which represents even logically and diagrammatically what actually took place when the problems of this experiment were solved. That is, in 180 problems, solved by 10 subjects presumably above the average in intelligence and training, there was no observable uniformity of procedure, either conforming to Dewey's analysis or suggesting any other set of requirements necessarily involved in a given case of thinking.

Of course, nothing like a pattern in the sense of a chronological sequence would be expected. But the results of this study show that even less than in temporal sequence,[2] is regularity to be expected in the nature of the activities which go into the solution of a problem. True, there are some events which are more likely to happen than others, and there are certain processes which are definitely connected with particular circumstances. But there is no discoverable combination of events which is indispensable to the solution of a problem; and, with the single exception of participant behavior, there is no one kind of activity which is found to be invariably present in all cases of thinking in this experiment. The *lack* of uniformity and the possibility of great flexibility are the outstanding characteristics of the data from this point of view.

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[1] Dewey: *How We Think*, p. 68 ff.

[2] As a matter of fact the temporal sequences determined by the special kinds of orientation adopted toward particular problems were among the most uniform activities obtained in this experiment.

To begin with the points where the greatest regularity exists, the reactions at the beginning and at the end of a problem show the greatest uniformity. All the 180 problems were alike in beginning with participant behavior, and in 83 per cent of them, the solution marked a definite turning point. But even in these respects, the procedure was not absolutely uniform. The participant responses might involve very simple or very complex activities, depending largely on the circumstances which brought them out; and at most, they indicate only a general tendency to respond to a problem in a positive and active way. And though the solution was usually a definite event, it does not indicate absolute uniformity of procedure. Both the processes that preceded it and those that followed it show the possibility of diversity of behavior. Still, accepting these regularities at their maximum value, they mean only that the greatest uniformities in thinking appear before it is well started and after it is practically finished.

The response which ranks next in uniformity is the orientation to particular problems. It has been shown that, in problems of the same class, the procedure is likely to be similar in general outline. But this fact, when analyzed, becomes an indication of diversity of activity rather than uniformity, since the different kinds of adjustments are ways of changing the response to suit the particular conditions of the problem. Whatever uniformity appeared was induced by the objective conditions which made several problems alike. Doubtless the variety of adjustments would have been increased by the addition of other kinds of problems.

As regards the detailed processes resulting in analysis, synthesis, and the discarding and supplying of content, uniformity exists insofar as most of them were responses common to all subjects and connected with similar circumstances; but the circumstances themselves were complex events and consequently irregular in appearance. Besides, none of the processes of detailed manipulation can be regarded as indispensable to the solution of a problem; there is not one which was not absent from one or more of the problems without preventing a solution.

On the whole, the trend of the evidence is to call into question the existence of a "complete act of thought" as an

actuality. In addition, there are several specific points in Dewey's analysis with which the results are at variance. But it must be recognized, before a detailed comparison is undertaken, that there are certain reasons why the "complete acts of thought" which appear in this study might be expected to differ from the "complete acts of thought" which Dewey describes.

In the first place, the acts of thought brought out by this experiment are empirically determined occurrences. They include any kind of thinking that happened to take place, and are complete acts of thought only in the sense that they include everything that was necessary, as an actual matter of experience, to bring about the solution of a problem. But Dewey recognizes several different kinds of thinking and his "complete act of thought" refers only to thought activity at its best; or, as he calls it, "reflective thought—thought in its eulogistic and emphatic sense."[3] It may therefore be regarded as a standard of thinking and the failure of particular specimens to conform to it may mean simply that they represent thinking of an inferior quality. Still, it is significant that, when examined under laboratory conditions, the thinking of ten individuals, presumably superior in that respect, did not exhibit the characteristics of superior thinking.

In the second place, it is possible that the conditions of this experiment—especially the fact that they reduced the subject to ignorance—are responsible for the differences that exist. The subjects were not dealing with materials with which they were familiar—i.e., to which they had acquired certain responses, and which had already undergone a certain amount of treatment at their hands. As a consequence, it is possible that they were placed at a disadvantage, so far as the higher processes of thought are concerned. But this is merely saying that the machinery of thinking, even in intelligent and trained individuals, when unsupplemented by adventitious aids which come through experience—i.e., through acquired responses to the material dealt with—is reduced to this primitive level of activity. Certainly, there was nothing in the conditions of the experiment to deprive the subjects of the use of any of their thinking mechanisms as such.

[3] Dewey, op. cit., p. 5.

But whatever the reason for the differences that exist, it is worth while noting what the differences are. If a comparison does nothing more, it will show how thinking, as it actually occurs in the conditions described, differs from standard or "reflective" thinking.

According to Dewey, thinking begins with a felt difficulty which may be vague at first and later definitely located, or which may be definitely located from the start. As to the role of difficulty as a stimulus to thinking, this study has the following lines of evidence.

(1) The first is that a felt difficulty does not seem to be an experience commonly associated with the beginning of a problem. It was almost never reported in connection with first reactions, particularly in the problems that were most likely to stimulate the more elaborate forms of thinking immediately—i.e., problems with clues. In fact, problems with clues were often described as "easier" or "more comfortable," in spite of the fact that they led directly to rather strenuous responses. But this fact in itself does not denote the absence of difficulty. It may mean simply that the difficulty was recognized without being acutely felt—or that so much difficulty as is involved in meeting a situation for which one has no response, was taken for granted.

(2) But the behavior during the first part of the problem shows that whatever difficulty is involved in meeting the first situation is not sufficient in itself to stimulate thought. Only in problems with clues does the serious business of thinking begin at once—i.e., only in problems where the first situation represents difficulty plus information. In other problems, the activity begins with a series of exploratory participant reactions, and only after a certain amount of experience has been accumulated, do the more complex activities begin. This looks as if difficulty plus experience, and not mere difficulty, were the effective stimulus to thought.

(3) Besides, when difficulty appears during the course of a problem, it is not particularly likely to stimulate thought, unless the subject has achieved some successes. Certainly when it is most keenly felt, it does not give rise to the more elaborate forms of thinking. The feeling of difficulty, in this experiment, was most frequently associated with inability to think of anything to do and usually followed a series of fail-

ures which exhausted a subject's supply of responses. The failure of difficulty to arouse thought in these circumstances is another indication that difficulty in itself cannot be regarded as the stimulus of thought.

(4) A fourth line of evidence is that successes sometimes have an immediately stimulating effect. This fact has been brought out in several connections and the details of the situation need not be repeated here. This state of affairs probably means that successful experiences with a given situation form one of the ways in which definite information regarding it may be acquired; and that when such an event occurs against the background of difficulty, which is necessarily present so long as the problem remains unsolved, both conditions necessary to stimulate thought—difficulty and knowledge—are fulfilled. Continued difficulty simply intensifies one of these conditions without supplying the other.

(5) Finally, the event which Dewey calls the "location of the difficulty" occurred as he described it in only 23 instances in this experiment; and all 23 of those cases, whether they took place in problems with or without aids, occurred after the midpoint. That is, approximately half the thinking had been done before they appeared. Furthermore, it is worth noting that they did not and could not appear until certain parts of the situation had been satisfactorily managed and had thereby become contrasted with the difficult parts. There were two other reactions, the "perception of a difference" and the "cleavage response" which sometimes incidentally involved a location of the difficulty and which, if included, would increase the frequency of the event. But there are a number of problems in the experiment—all the solutions of Problem A I, 6 of Problem A VI, and several others scattered sporadically through the other classes of problems—in which none of these responses appeared; and insofar as these cases involved thinking at all, it was thinking of a sort which did not include the location of the difficulty.

Summing up the evidence on this point, the facts indicate, not that difficulty is not a necessary stimulus to thought, but that it is not *the* stimulus—that it does not operate unless the situation to which it attaches is one about which the subject knows something. That is, the situation which arouses thought must evoke *some* responses, but not *the* response. The

feeling of difficulty is probably connected with the fact that *the* response is absent; but the presence of other responses probably implies successful experience with parts or aspects of the situation—or else some substitute for successful experience, such as instinctive equipment, or information accompanying the presentation of the problem.

Of course Dewey's analysis does not imply that thinking can go on in response to a situation which evokes no reactions at all. He does emphasize the factor of difficulty, however, possibly because a certain amount of familiarity with the materials of everyday life is taken for granted. But this experiment, which deprives the subject of the use of his everyday knowledge, reveals the importance of successful experience. It shows that one of the general conditions of a problem capable of arousing thought is that it evoke definite responses of some sort; and that previous successes may be a means of connecting definite responses with the situation. And, in particular, it shows that concrete successes, occurring in the course of an unsolved problem, have a certain advantage over failures as stimuli to thought.

As regards the next step, called "suggestion of possible solutions," the results of this study are essentially in agreement with Dewey's description. What he means by suggestion is evidently what, in this study, has been called participant behavior; or rather, that side of participant behavior which is involved in calling up one hypothesis after another. This was the one activity indispensable to the solution of a problem, according to this study. Logically, it is conceivable that spectator behavior alone might effect a solution, but actually, in this experiment, it did not.

The next step mentioned by Dewey, "the development by reasoning of the bearings of the suggestions" was present only rarely. Or it would be more accurate to say that approximations to it sometimes occurred; for there is no case in the record in which a subject systematically thought out all the implications of a situation and investigated them with any thoroughness. The hypotheses were tried out in the sense of being put to the test of experience, but were not systematically examined and varied. In particular, a reaction which had been associated with failure was likely to be discarded altogether, when, logically, with some slight varia-

tion, it might bring success. Instead of displaying a rational working out of logical implications, the procedure revealed a tendency to let the solution shape itself in the course of participant activity.

Finally, the last step, verification, was extremely rare, so far as anything like logical corroboration is concerned. In fact, there were only 11 cases of it reported in the entire experiment. The uncritical acceptance of successes was the rule rather than the exception.

Summary

It is possible to regard the results of this study from two points of view.

The first begins with an empirical definition of thinking as that which happens when individuals solve problems. From this point of view, the specimens provided by this experiment would be accepted at their face value as the productions of superior human beings, actually engaged in thinking, in conditions which reduced them to *mere* thinking—i.e., to thinking, minus the aids which previous experience with the material contributes. According to this definition and on the basis of these specimens, the evidence for a group of activities constituting a complete act of thought is negative. The total effect is that of flexibility and irregularity—responsiveness to the particular details of the situation. Thinking, then, becomes a collective term applicable to any set of processes which appears during the course of a problem.

The other point of view begins with a logical definition of thinking as necessarily including certain activities. From this standpoint, the evidence shows how far removed from standard thinking are the actual responses of even superior human beings, when they are reduced to *mere* thinking. It suggests that the "complete act of thought" is an ideal, or a description which may apply to rare cases of thinking, but not an actuality commonly discoverable in experience.

CHAPTER XIII

Conclusions

In this chapter, no attempt will be made to summarize all the results of this study. As it stands, the whole paper can be regarded only as an incomplete résumé of the complex processes investigated. Only those features will now be mentioned which, in this particular set of conditions, stand out most clearly, and which are sometimes less apparent when thinking is examined from other points of view.

I. *Spectator Behavior*

The first is the existence of spectator behavior. Though the possibility of this kind of thinking has long been considered—and was even assumed by Bacon as the basis of his proposed scientific procedure—it has not appeared in actual experiments on thinking. In the experimental studies, trial and error has been the common response—certainly the response which has received the emphasis. In this study, however, it becomes apparent, even from a superficial examination, that something not exactly trial and error takes place; and when this behavior is examined in detail, it is found to represent a different attitude. It sometimes gives the impression of mere outward compliance with the conditions of the experiment when the regular participant response is blocked; but at other times, it evidently means the adoption of a receptive general set, permitting impressions, not specifically attended to, to be registered. Indeed, this set is sometimes taken on very definitely and a particular hypothesis used as an instrument of observation; that is, the subject, without knowing exactly what he is looking for, provides a nucleus for his observations.

Besides, outside the field of spectator behavior proper, there are incidental indications that such activity occurs. Something of the sort is indicated by the stamping in and summation activities which seem responsible for some of the forms of analysis and synthesis—the kind of analysis in which cer-

tain features are almost mechanically isolated, and the kinds of synthesis in which general ideas and general sets are formed. A particularly good illustration is found in the appearance of new responses as a result of the summation of impressions not specifically attended to, but which nevertheless register the general drift of experience. In all these cases, spectator behavior evidently occurs as a side activity, while the participant response receives the major part of the attention.

This indicates, as a possible state of affairs, that something like spectator behavior is always going on to a certain extent—that in addition to the activities directly attended to, the organism is registering other impressions incidentally. Naturally, then, when participant behavior is blocked, spectator activities may appear in isolation. This would explain the failure of spectator behavior to appear in most experimental studies. Whenever material is used, sufficiently rich in detail to permit participant behavior, that response would naturally be aroused; and spectator activity, which would then occur as an incidental affair, would either be overlooked or regarded as an integral part of trial and error. The material of this study is especially likely to exhibit spectator behavior in isolation because of the limited number of particular features it presents for the participant procedure to utilize.

II *The Role of Successes in Thinking*

The second point brought out by this study is the role of successes in thinking. The fact that success may be important in stimulating thought has appeared in several ways. The first indication occurred in connection with participant behavior, where the irregular form involving change of reaction after success was found to include events involving definite progress toward solution—where, having just achieved a success, the subject, in his next response, might think of another hypothesis to account for the facts, enlarge his field of reaction by responding to new or different features of the situation, or simplify his response through a more complete generalization. Then, too, successes were found to have

an immediately stimulating effect on some of the higher processes of analysis and synthesis; besides, they were evidently essential in some of the methods of developing new responses —particularly in stimulating the complex activity involved in "thinking out" a new idea. In addition, verification, one of the processes that occurred, though rarely, after solution, was obviously stimulated by success; and the occurrence of other activities, both similar and dissimilar to those appearing before solution, showed at least that they did not require the stimulus of failure. In the study of orientation, it was found that the subjects began their activities with correct rather than incorrect samples when both were available—that is, used artificial successes in preference to artificial failures as the basis of their operation. Finally, when each problem was taken as a unit, or as a "complete act of thought," it became apparent that thinking was not initiated by difficulty alone, but that success played an important part in bringing it about; that in order to stimulate thought, a situation must not only be one to which the individual does *not* possess the right response, but one to which he *does* possess several responses; and that one of the ways in which a situation may acquire definite stimulus-response connections is through the individual's successful experience with similar situations or aspects of the situation.

The role of success may be summarized as follows. In the first place, success may be instrumental in bringing about one of the general conditions constituting a problem; it may be an essential part of the background necessary for the production of thought. In the second place—and this is the point which is made particularly evident by the conditions of this experiment—concrete successes, occurring in the course of a problem, are found to have a specifically stimulating effect on certain processes involved in thinking. When they come in this way, they may even have a certain advantage over failures, in that they sometimes supply a missing condition necessary to thought, whereas failure only intensifies an existing condition. But on the whole, the factor of success is not intrinsically more important than that of difficulty. It has been emphasized chiefly because difficulty and failure are the features commonly stressed.

III *No Special Process or Combination of Processes Necessarily Involved in Thinking*

The third point is something which has little novelty in psychological studies, where it is a common experience to find that the activity investigated is not a unitary process. However, it is worth emphasizing because it came out repeatedly and in so many ways. It may be summarized by saying that most of the words used in describing thinking are merely collective terms—and that, properly, they do not refer to processes, but only to results produced. The word "thinking" itself is an illustration of this point; and this means not only that it includes many different activities —a fact sufficiently obvious—but that all thinking does not involve the same activities; that there is no special process or combination of processes to correspond to the term. The same thing may be said of such words and phrases as analysis, synthesis, and the discovery and elimination of responses. When the data are inspected, these terms are found to be inapplicable except as designations of results produced. There is no process of analysis, for example, but a number of processes which differ widely in nature, though they produce a common result. In other words, when the products of thought are examined, the tendency is to notice that certain results have been produced and to infer a process to correspond to each result; but when the processes themselves are observed, no evidence is found to justify the inference. The terms, however, are in general use and it may be well to recognize that there are no special psychological processes to correspond to them.

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